HP bh5700 ATCA 14-Slot Blade Server

Ethernet Switch Blade

First Edition

Manufacturing Part Number: AD171-9603A

June 2006

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About the Ethernet Switch Blade Manual

This manual includes everything you need to begin using the HP Ethernet Switch Blade with OpenArchitect software, Release 3.2.2j.

Table of Contents

Table of Figures

Index of Tables

Chapter 1 Overview of the Ethernet Switch Blade

The Ethernet Switch Blade is a 72-port AdvancedTCA® Hub and providing Gigabit Ethernet. Up to 14 ATCA node boards may be addressed via the PICMG 3.0 Base Interface and via the ATCA PICMG 3.1 fabric . The Base and Fabric switching domains are kept totally separate, both on the physical layer and the software layer. The Ethernet Switch Blade provides a tightly integrated modular switching platform that enables high-density solutions.

The Ethernet Switch Blade is actually two separate switches, one for the Base ports and one for the fabric ports. There are two OpenArchitect® operating system images, one for each switch, allowing the maximum in separation between the control signaling and the data. The modular design provides great flexibility and control.

Ethernet Switch Blades can support a 10 Gigabit Ethernet Inter-Switch Link (ISL) for the Fabric Interfaces, and a Gigabit Ethernet ISL for the Base Interface switches. Depending on the version of OpenArchitect used, the ISL for the Fabric Interface switches may be operated at 10 Gigabits per second and provide stacking features.

Linux-based OpenArchitect 3 runs on the embedded processors, providing a comprehensive package for the management of Layer 2 and Layer 3 packet switching. VLAN management and Layer 2-7 packet classification are also included with a user-friendly interface. OpenArchitect can be used with a variety of IP routing protocols.

As part of Advanced TCA, the switch incorporates the PICMG 3.0 Intelligent Platform Management Interface (IPMI) standard for Field Replaceable Unit FRU) management by the Shelf Manager.

High Performance Embedded Switching

The Ethernet Switch Blade with OpenArchitect combines the performance of silicon-based switching fabric with flexibility of software-managed routing policies. It provides Base fabric PICMC 3.0 (1 Gigabit Ethernet) links to each of the payload slots, plus two to four PICMC 3.1 in-band GigE ports to each node card, and GigE links to management ports and the second switch. The Ethernet Switch Blade maintains the forwarding table on silicon, providing the capability to switch and route at full line rate performance on every port.

Advanced TCA® Compliant

The Advanced TCA® standard developed by the PCI Industrial Computer Manufacturer Group defines an embedded Ethernet environment for high availability chassis. This environment includes two switch fabric slots that create a dual star Ethernet network to the 14 Base node slots. Placing the Ethernet Switch Blade in a hub slot provides embedded Ethernet services to each node card of the chassis. A standard HA configuration is one Ethernet Switch Blade placed in each of the two hub slots in a chassis for creation of a redundant, high availability system.

OpenArchitect Switch Management

The OpenArchitect software component – open source Linux, IP protocol stack, control applications and the OA Engine – runs on two embedded PowerPC microprocessors. OpenArchitect provides extensive managed IP routing protocols and other open standards for switch management. Examples include network services; Virtual Redundant Router Protocol; Routing Information Protocol; Open Shortest Path First; Border Gateway Protocol; Quality of Service and Class of Service; access control lists; Simple Network Management Protocol MIBs, Common Open Policy Services and web.

Extensible Customization of Routing Policies

The OpenArchitect software environment enables rapid porting of other UNIX/Linux-based protocols, including open source software conforming to RFCs and other standards. It also enables the development of application-specific protocol configuration scripts.

Powerful CarrierClass Features

The Ethernet Switch Blade has High Availability hardware features for advanced telecommunication applications. The switch implements the PICMG 3.0 Full Hotswap support. This feature provides field replaceable capabilities so a switch can fail and be replaced without impacting the operational performance of a chassis.

The PICMG 3.0 Intelligent Platform Management Interface (IPMI) standard is also supported. IPMI uses message-based interfaces that monitor the physical health characteristics of the Ethernet Switch Blade. The switch provides operational status information to an IPMI management application. End customers benefit with advanced notice of potential problems.

The Ethernet Switch Blade also implements the Media Dependent Interface called Auto MDI-X. Auto MDI-X allows connections to any device, switches, hubs, or systems using a regular straight-through or crossover Cat 5 cable. The RJ-45 port will auto detect and switch MDI/MDI-X modes. This IEEE standard makes cabling – especially between switches – faster and less error prone.

E-Keying is supported by the Ethernet Switch Blade.

Ethernet Port Layout

The Ethernet Switch Blade has a total of 72 switched Gigabit Ethernet ports. The base fabric is connected via 24 Gigabit Ethernet ports and the data fabric is connected via 48 Gigabit Ethernet ports. The Ethernet Switch Blade is actually composed of two separate switches, one for Base port activity and another for fabric port activity. The Base ports (control and signaling) are switched on the Base switch, and the fabric ports (data) are switched on the fabric switch, which provides total separation between system management or control packets, and customer data packets.

Ethernet Switch Blade Port Configuration

Base switch Quick Reference

ShelfManager1	zre22
ShelfManager2	zre13
ISL channel (Base node2)	zre23
Base nodes 3-14	zre0-11
Base nodes 15,16	zre 20-21
Front panel	zre12, zre14, zre15

Fabric Switch Quick Reference

slot	zre numbers
3	zre0-3
4	zre4-7
5	zre8-11
6	zre12-15
7	zre16-19
8	zre24-27
9	zre28-29
10	zre30-31
11	zre32-33
12	zre34-35
13	zre36-37
14	zre38, zre39
15	zre40-41
16	zre42-43
Inter-switch Link (ISL)	zre51
Front panel	zre20-23

You will find the Ethernet Switch Blade has a straightforward installation and configuration. UNIX or Linux system management skills and some understanding of network protocols will be required. Configure the Ethernet Switch Blades to your networking application before you begin using the OpenArchitect switch.

OpenArchitect Switch Environment

The key elements of the OpenArchitect environment include two embedded Linux operating systems, OpenArchitect-specific applications and libraries, plus, an innovative switch hardware design.

OpenArchitect hardware is in many ways similar to typical switch architectures. The primary difference in OpenArchitect is that the PCI bus that interfaces with the embedded processor and the switch fabric is at a higher performance level than a typical switch (see Figure 1.1: Fabric Switch Elements). The use of PCI creates a pipe of significant bandwidth between the processor and the switch fabric.

The embedded processors, running Linux and the OpenArchitect processes, control the flow of all traffic by maintaining the switch forwarding tables. These tables define the flow of the switch traffic. Because they are on the switching chips, packets proceed at line rate.

OpenArchitect Software Structure

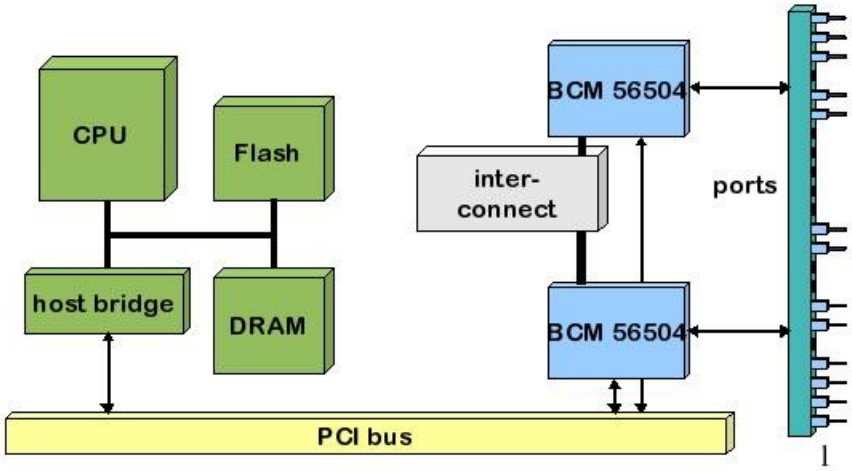


Figure 1.1: Fabric Switch Elements

OpenArchitect is based on an embedded Linux operating system and includes a number of ZNYX Networks-supplied modules. The key element is the Linux routing table, which is crucial in a

network-enabled Linux implementation.

The purpose of the routing table is to tell the packet forwarding software where to forward the data packets. In Linux, the packet-forwarding algorithm is operated in software. Normally, the routing tables are maintained by operator configuration and the various routing protocols that run in the application environment of Linux.

OpenArchitect uses an innovative new approach for forwarding packets. It provides embedded software daemons that replicate (shadow) the Linux routing tables in the silicon-based forwarding tables (see Figure 1.1: Fabric Switch Elements). In the OpenArchitect switching environment, the switching chips do the real-time work in switching network packets. The switch fabric consults its own forwarding tables for each incoming packet; and either filters or forwards the packet to any egress port, the embedded CPU, or to any combination. The Linux routing tables, running in software, are used to update the silicon-based tables. This provides both the flexibility and control of the Linux software environment and the speed of dedicated switching silicon.

The OpenArchitect environment includes additional features. For example, installing the OpenArchitect switch gives you immediate implementation of Linux routing protocols. Also, you have complete support of routing table updates and a standardized method for configuration. Finally, you can quickly integrate bug fixes, protocol enhancements and additional protocol implementations from the Linux community. You can also integrate OpenArchitect into other Linux applications including VPN software, voice over IP protocols, Quality of Service, and HTML configuration.

RAIN Management API (RMAPI) is a generic interface for passing control data. The OpenArchitect libraries are implemented completely above RMAPI. The libraries provide a front-end to RMAPI to simplify application writing. Currently one library is implemented, a general library called `zlxlib`. As the OpenArchitect application requirements grow, the existing library will be expanded and additional libraries will be created.

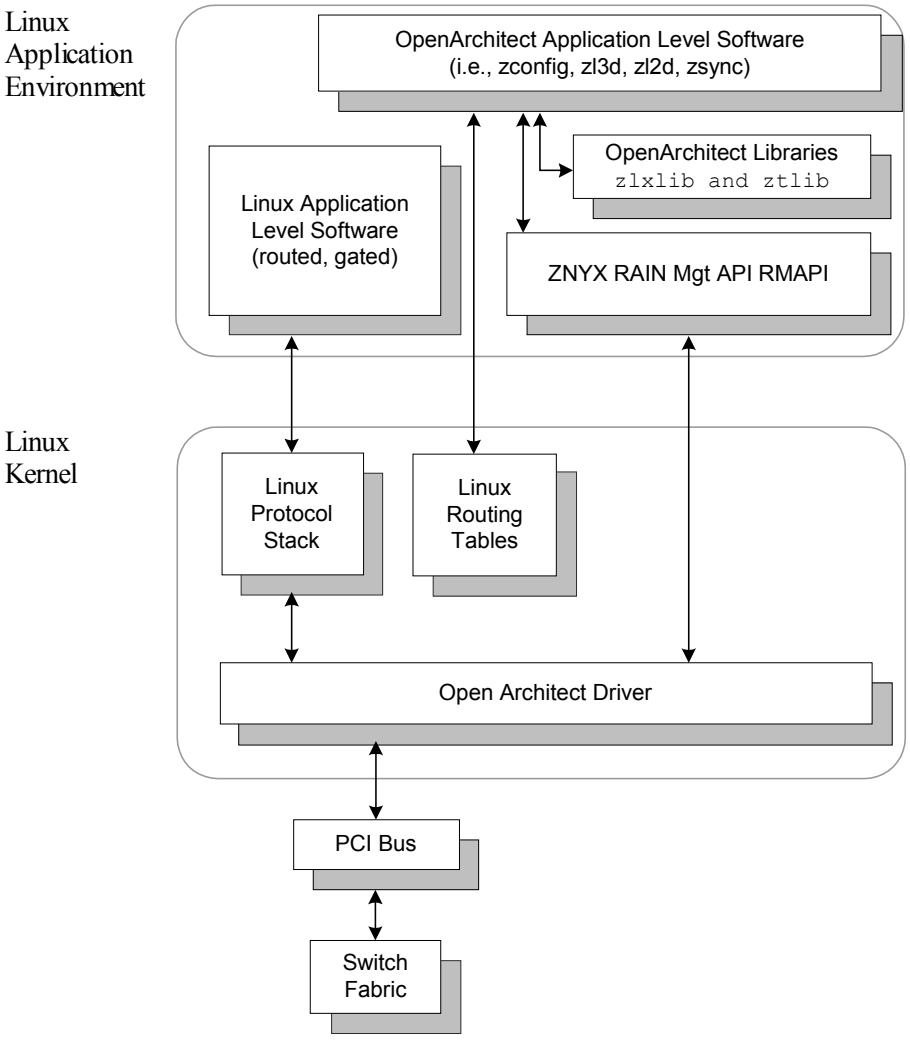


Figure 1.2: OpenArchitect Software Structure

OpenArchitect applications are used to program and configure the Ethernet Switch Blade. These applications are implemented above the libraries and RMAPI.

Chapter 2 Port Cabling and LED Indicators

The PICMG 3.1 standard defines an embedded Ethernet environment for Telco chassis. This environment includes two switch fabric slots that create a dual star Ethernet network to the fourteen node slots. Placing the Ethernet Switch Blade in a hub slot provides embedded Ethernet services to each node card across the Packet Switching Backplane of the chassis. A standard configuration is to place a Ethernet Switch Blade in each hub slot creating a redundant, high availability system. This chapter provides information on the Ethernet Switch Blade port connectors and LED indicators.

Connecting the Cables

Your switch setup may require some or all of the following types of cables: 10/100/1000 Port Cabling

Category 5 cabling is required for all external ports. Be sure that your cable length is within the minimum and maximum length restrictions for the Ethernet, otherwise you could experience signal or data loss. All copper GigE ports on the Ethernet Switch Blade are auto-MDI sensing and will automatically determine whether or not an MDI (straight-through) or MDI-X (crossover) cable is attached.

Console Port Cabling

The switch console can be accessed via one RJ-45 10/100 service port located on the front panel of the Ethernet Switch Blade.

NOTE: There are two switch portions that make up a Ethernet Switch Blade unit. Each switch portion, Base and fabric, has its own console ports, and requires its own console cable or OOB Ethernet cable.

The RS-232 configured RJ-45 connector console port on the front panel can be used to recover from a system failure. It is used for maintenance only, and is generally not connected. Use a HP console cable (P/N A6900-63006) provided with the HP bh5700 ATCA 14-Slot Blade Server, in combination with a Modem Eliminator cable, to access the switch software through the console port. Refer to the *HP bh5700 ATCA 14-Slot Blade Server Installation Guide* for additional information.

Connecting to the Console Port

To attach the console cable to the OpenArchitect Base or fabric switch:

1. Plug the RJ-45 end of the console cable into the RJ-45 Console Port on the front.
2. Connect the Modem Eliminator cable to the DB-9 connector on the console cable.
3. Connect the other end of the Modem Eliminator cable to a standard COM port (9600, n, 8, 1).

4. Reinsert the switch into the shelf chassis and power up.

Use a terminal emulation program to access the switch console.

Out of Band Ports (OOB Ports)

Each switch, fabric and Base, in a Ethernet Switch Blade unit has out-of-band (OOB) Ethernet ports on the front panel. This is an alternative maintenance port supplying Ethernet connectivity instead of serial connectivity and is connected only when performing switch maintenance activities. Use `ifconfig` to bring up and configure the OOB ports. The OOB ports are 100 full duplex, not auto-sensing. The front OOB port is eth0, and the rear (not implemented with this release) is eth1.

LED Reference

See Figure 2.1 for a schematic view of the front of a typical Ethernet Switch Blade board. Note that there are out-of-band ports, RS232 ports, a USB port, and 10 Gig egress ports (not implemented in this release). In-band ports from the Base and fabric switches have LED status lights controlled from the LED Mode button. Press the button successively to display the Base switch ports, fabric switch ports 0-23, and finally the fabric switch ports 24-47. There are separate LEDs for the out-of-band ports, and the ATCA status functions.

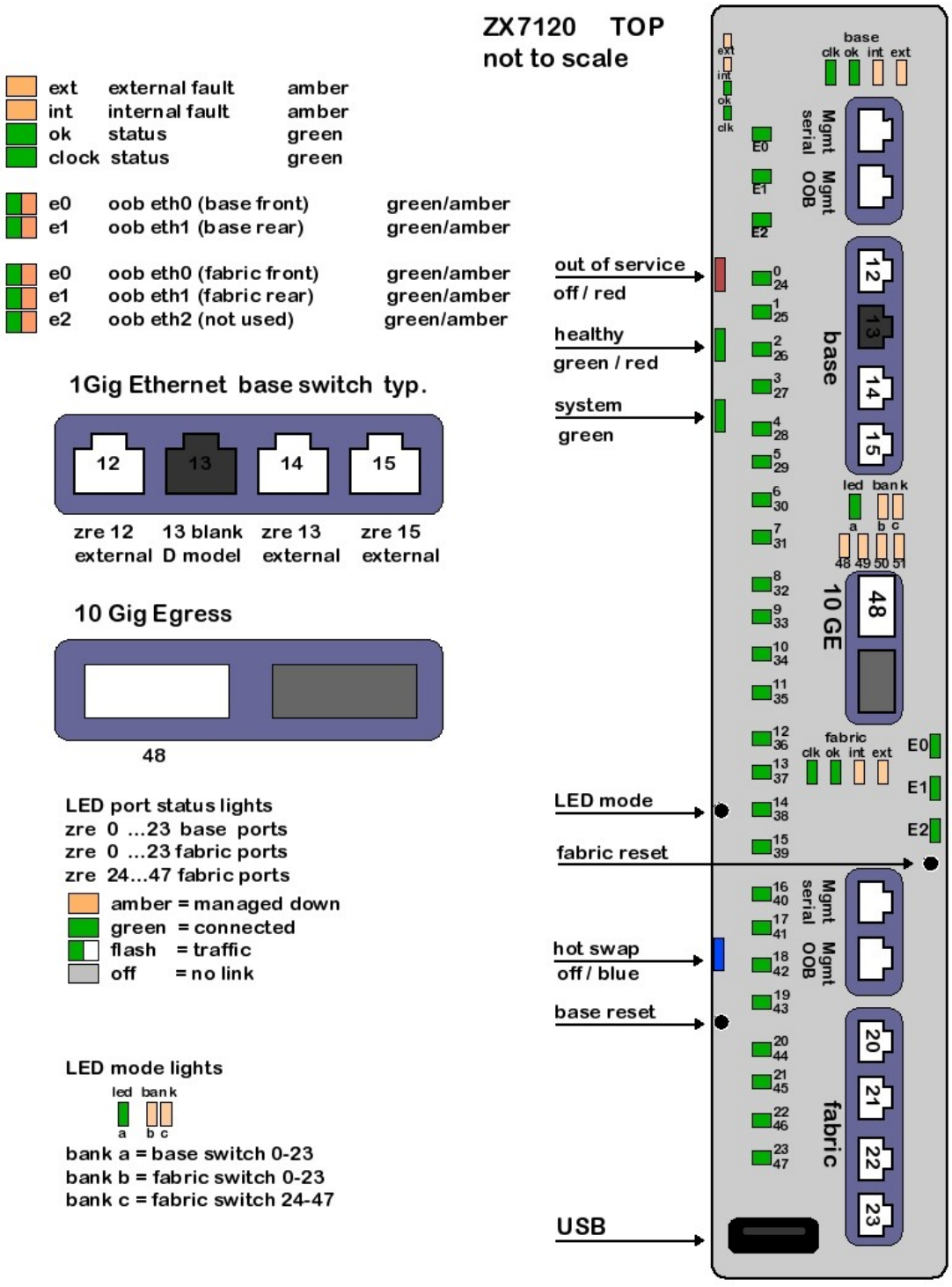


Figure 2.1: LED Reference

Chapter 3 High Availability Networking

High availability networking is achieved by eliminating any single point of failure through redundant connectivity: Redundant cables, switches and network interfaces for hardware, combined with HA software solutions on both the hosts and switches to control the HA hardware and maintain connectivity. An HA solution called Surviving Partner is provided on the switch.

For host-side HA, the most common solution is to use the Linux bonding driver. HA solutions like the Linux bonding driver present a single, virtual interface to the protocol stack while managing multiple physical links. Figure 3.1: Host HA Architecture shows the relation of the protocol stack, a bonding driver and physical ports.

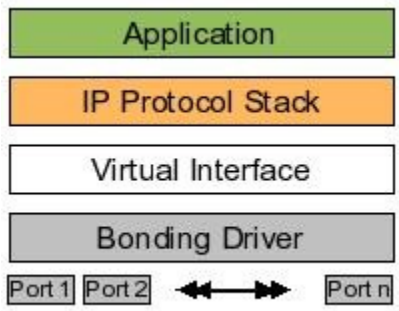


Figure 3.1: Host HA Architecture

A failover between physical links can be made very quickly without requiring change to the IP or MAC address of the virtual interface, effectively transparent from the applications point of view. With redundant links from a switch (or switches) to the host, one link is maintained as the ACTIVE link and the other as STANDBY. If the ACTIVE link were to go down, the STANDBY becomes the new ACTIVE, while presenting the same virtual interface to the host.

NOTE: It is important that the bonding solution provide an active-backup mode. For the Linux bonding driver set "mode == 1" see the *http://sourceforge.net/projects/bonding/* documentation for more information. Use the recommendations for Linux kernel 2.4x not 2.6x.

Redundant connections provide an ACTIVE and STANDBY link to a switch, or provide redundant links between more than one switch. In the case of more than one switch, a complete HA solution requires a switch-based HA solution.

Surviving Partner

Surviving Partner is a switch-based HA solution. Surviving Partner runs on the switches to provide transition of Layer 2 and Layer 3 switching functionality between two or more switches. Surviving Partner is comprised of many interactive protocols and processes including *VRRP*, `zlmd`, `zlc`, and others.

VRRP

Since most end nodes use default router addresses, the change of the default router address during a switch failover would require the end nodes to reconfigure. Layer 3 switches that failover must maintain the default router address to maintain the end node's IP transparent failover. The Virtual Router Redundancy Protocol (VRRP, RFC 2338) running in the Surviving Partner switches provides transparent movement of the default router address. VRRP maintains the notion of a Master switch and one or more Backup switches. This group of switches presents a virtual router IP address that can be used by hosts on that net as their default route.

If a Backup switch determines the Master switch is no longer available, one of the Backup switches will assume the role as Master. Physically, each switch maintains a link to the local network. Only the Master switch answers to the default gateway, and the hosts on that net have no need to relearn the router address.

In an HA configuration, the goal is to avoid any single point of failure. VRRP provides a good mechanism to provide a static route for a local network, but a true HA configuration must also provide redundant connections for the host. Providing a virtual router for the local network is not enough. Take the simple case of two hosts on the local network with a connection to the virtual router. Each host needs a connection to each physical switch participating in VRRP. In the simplest configuration, each host would have one connection to the network. An HA solution would include redundant connections from each host to each switch in the virtual router.

Combining the features of Surviving Partner on the switches and HA bonding drivers on the hosts allows implementation of this true HA configuration.

`zlmd`

In addition to complete switch failover, single link failure must be properly handled. The Link Monitor Daemon `zlmd`, monitors the link status of each port. If a link goes down, `zlmd` communicates with the VRRP daemon (`vrrpd`) to change its priority. Changing the VRRP priority results in movement of switching functionality. By combining `zlmd` with the `zlc` application, links connected to hosts that have not failed can be deterministically moved to the new master switch if desired. Supported modes include:

- **switch -** The switch with the greatest number of UP links becomes the Master for all VLANs under HA management.
- **Vlan -** The switch with the greatest number of UP links in that particular VLAN becomes the Master for that particular VLAN. If the switch has additional VLANs, they each change independently.
- **Port -** The Master will remain the Master for that particular VLAN until all ports in that VLAN are down. The Backup then becomes the new Master for that VLAN. Failed links move their connectivity through the Backup Switch and the switch interconnect to reach the Master Switch. This option alleviates the need to move all nodes to a new switch just because a single link goes down.

NOTE: All modes require inclusion of the interconnect in the VLAN. The ISL connection between the two Base switches is port 23 for the Ethernet Switch Blade. The ISL connection between the two fabric slots in port 51.

Switch Replacement and Reconfiguration

When a switch fails, it must be replaced. The replacement switch will likely require proper configuration. For transparent switch replacement, the newly replaced switch must learn its configuration from its Surviving Partner.

In a simple failover scenario, Host A and Host B are configured with failover between two host ports, one port connected to Switch A and the other connected to Switch B. Assume Switch A provides connectivity between Host A and Host B. If Switch A fails, the active link on each host moves over to the port connected to Switch B. Surviving Partner software on Switch B recognizes that Switch A has failed, and assumes the role of switching traffic between Host A and Host B. When the failed Switch A is replaced with a new Switch A', Switch A' will learn its network configuration from the surviving partner Switch B. Switch A' is now ready as a backup to Switch B in case of failure of Switch B.

This is achieved through the use of DHCP. When a switch becomes a VRRP Master, a DHCP server is started with a pointer to a configuration file that contains configuration information for its partners. The replacement switch comes up running DHCP client to retrieve its configuration.

Proper configuration of Surviving Partner requires coordinated configuration of many different processes, including `vrrpd`, `zlmd`, `zlc`, and `dhcpd`. The daemon processes run scripts to perform their actions. Because these scripts are complex and inter-dependent, a configuration application called `zspconfig` is used to build them.

The basic steps to configuring Surviving Partner are:

1. Determine your desired configuration.
2. Modify the configuration file (`/etc/rcZ.d/surviving_partner/zsp_DC.conf` is the default) to use as input to the configuration utility (`zspconfig`).
3. Configure startup scripts or other scripts such as `gated` routing scripts and `vrrp` configuration scripts.
4. Run `zspconfig` on the Master system.
5. `Run zspconfig -u` on the Backup/Sibling system(s).

`zspconfig`

`zspconfig` performs the job of building the scripts based on a provided input file locally, or from a remote machine. A text-based configuration file provides input to `zspconfig`. Example configuration files are included on the switch in `/etc/rcZ.d/surviving_partner`. The result of `zspconfig` is to create several configuration files and runtime shell scripts, and optionally start the Surviving Partner processes. Scripts are generated for configuring VLANs, starting the network, and starting the `vrrpd` and `zlmd` daemons.

`zspconfig` can also used by sibling backup switches to retrieve configuration from the Surviving Partner and start the `vrrpd` and `zlmd` daemons. `zspconfig` is generally only run once to configure Surviving Partner.

The configuration and runtime scripts created are as follows:

- **S70Surviving_partner** Switch initialization script that is run at boot time. This script will restart the switch with the original configuration given to `zspconfig`. Optionally, `zspconfig` will run this script from the initial invocation.
- **zsp.conf.<n> -** `zspconfig` configuration file that contains the configuration of the sibling backup switches. The <n> is used to distinguish potentially more than one backup switch. This configuration file is placed in `/tftpboot`, and is retrieved via DHCP during configuration of the backup switch by `zspconfig` with the "`-u`" option or, by a replacement switch on boot up.
- **vrrpd.conf -** Configuration script for the VRRP daemon. This configuration is used when the S70Surviving_partner script launches vrrpd. There is a line in this file for each virtual router address vrrpd will manage.
- **dhcpd.conf -** Configuration script used by `dhcpd` when the switch becomes master. `dhcpd` is also used to give replacement switches their configuration scripts. Namely a zsp_.conf<n> file that can be input to `zspconfig` with the `-u` flag.
- **dhclient.conf -** If `zspconfig` is executed with the `-u` flag, a dhclient.conf file is created, and then dhclient is used to retrieve a `zspconfig` configuration file from the /tftpboot area of the Master switch.
- **vrrpd.script -** Runtime script that executes each time the vrrpd changes state. This script starts and stops `dhcpd`, and toggles down RAINlink ports to force the RAINlink nodes to a new Master switch.
- **zlmd.script -** Runtime script executed by zlmd when a link goes up or down. This script modifies the priority of the vrrpd that in turn may cause the VRRP Master to move from one sibling switch to another.

After the scripts are created, `zspconfig` may run the `S70Surviving_partner` script to start the Surviving Partner tasks. The tasks started are vrrpd, zlmd, and `dhcpd`.

The `vrrpd` and `zlmd` daemons run scripts to perform their actions. When `vrrpd` changes state between Master and Backup, it runs a script that starts and stops `dhcpd`. When `zlmd` sees a link go up or down, it runs a script that communicates with `vrrpd` via `vrrpconfig`.

Example HA Switch Configuration

The following walks through a basic Surviving Partner configuration typical for an HA setup. Assume an HA chassis with multiple hosts, such as single-board CPUs, and two switches configured for Surviving Partner. Each of the hosts has two Base Ethernet ports providing a link to each of the Base switches and up to four fabric Ethernet ports providing links to each of the Fabric switches.

Each host runs Linux bonding drivers (or ZNYX OA Node software with embedded RAINlink) with the ports configured for failover. An interlink provides communication between the Base switches. Another interlink provides communication between the Fabric switches.

When using a Linux Bonding driver on the node card, the bonding driver should be configured for Mode 1 (active/standby). See the Linux Bonding documentation at http://sourceforge.net/projects/bonding/ for complete information.

The two Base switches will be configured as Surviving Partners, using VRRP to form a single virtual interface to the hosts, as will the two Fabric switches. The ports can be configured many different ways, with blocks of ports configured as vans. The configuration is set up in the zsp configuration file, `zsp.conf`.

NOTE: The actual name on the system may change slightly from `zsp.conf`, depending on current release requirements.

Modifying `zsp.conf` on the Base switch

An example file for setting up `zspconfig` on an Ethernet Switch Blade is `/etc/rcZ.d/surviving_partner/zsp.conf`. The following will document the default settings.

NOTE: It is unlikely that any installation will use this default script in production. You will have to modify it to suit your network design.

On Switch A (Master), make a backup copy of `zsp.conf`, and edit `zsp.conf`:

```
cd /etc/rcZ.d/surviving_partner/

cp zsp.conf zsp.conf.save

vi zsp.conf
```

The first section uses `zconfig` to create the VLANs. Many of these choices are determined by the physical configuration of the switch and ATCA backplane. For instance, the Base switch interconnect will always be port 23, and the shelf managers will be ports 22 and 13.

```
zconfig zhp0: vlan100 = zre23;

zconfig zhp1: vlan1 = zre0..11, zre20..21, zre23;

zconfig zre0..11, zre20..21 = untag1;

zconfig zre23 = untag100;
```

The next section sets up the physical IP addresses to use for the Master and the Backup switch. The Master provides the addresses to the Backup on a first come, first serve basis. Note that the physical IP address should be different from the virtual IP address that spans the pair of switches. Once configured, the pair appears as one connection point to other hosts on the VLAN. You need to supply an IP address for each interface on each switch. The first IP address on each line is the Master and the second is the Backup.

```
sibling_addresses: zhp0 = 100.0.0.30, 100.0.0.31 netmask
255.0.0.0;
```

```
sibling_addresses: zhp1 = 10.0.0.30, 10.0.0.31 netmask 255.0.0.0;
```

Now configure the virtual address for each sibling group. We are going to create a virtual interface across one VLAN, but not for the interconnect. This provides a single point to connect/route to the VLANs.

```
vrrp_virtual_address: zhp1 = 10.0.0.42 netmask 255.0.0.0;
```

Next come port definitions, as defined on the `zspconfig` man page. Since our hosts are connected using the Linux bonding driver (or RAINlink), we will want to choose `RAINlink` on each of the ports in VLANs on each switch, and *interconnect* for the interconnect port on each switch,

The port definitions are:

interconnect - Ports connected between groups of Surviving Partner switches. VRRP heartbeat messages are sent on the interconnect ports.

Crossconnect - Crossconnect ports are ports that are connected to other Surviving Partner switches, that are not part of this Surviving Partner group. Crossconnect ports behave differently then bonding driver/RAINlink ports. The links are not brought down temporarily, and VRRP runs with the native MAC addresses to avoid MAC address duplication with the other VRRP group.

RAINlink - Ports connected to bonding driver/RAINlink enabled nodes. These ports contain virtual addresses managed by VRRP. And during a failover event, the links are toggled down to force failover to the Master switch.

Route - Ports connected to upstream routers. VRRP does not manage virtual IP addresses for these links. Routing protocols must be used to instruct up stream routers of a different path to get to the VRRP managed networks.

monitor_only - Ports that are monitored but do not have a virtual address managed on them. They will not have their links brought down temporarily during a failover scenario. These ports are only monitored. If a problem occurs on this type of link it will cause a failover scenario.

configure_only - Ports are configured as per the `zconfig` commands, but do not participate in the high availability network. Problems on these links will not cause a switch failover.

```
interconnect: zhp0;

RAINlink: zre0..11, zre20..21;
```

Next come special modes for VRRP for use when more than one pair of Ethernet Switch Blades are connected to another pair of Ethernet Switch Blades in a redundant configuration. The intent of these modes is to provided Spanning Tree like capabilities eliminating network looks between pairs of Surviving Partner configurations, as well as expedite address learning between the two pairs of switches:

```
vrrp_mode: RAINlink_xmit_on_failover;
```

```
#vrrp_mode: block_crossconnect;
```

The next sections determines the failover mode between the Surviving Partner switches. There are three modes:

- **switch -** Failover by switch. Failover from Master switch to Backup on any port failure. The switch with the most links becomes the new Master. One port failure will cause the switch to failover.
- **vlan -** Failover by VLAN. The switch with the most up links in the VLAN becomes the Master of that VLAN. When VLANs failover and all VLAN masters are not located on a common switch, the interconnect link is used to carry data traffic, and could become saturated. The use of the interconnect for data traffic in a failover situation depends on the VLAN design, from one extreme where one VLAN could contain all ports to one port per VLAN at the other extreme.
- **port -** Failover by port. The Master switch will remain the Master until all ports in the VLAN are down. The Backup then becomes the new Master for that VLAN. Similar to VLAN failover, the interconnect link will carry data traffic in this mode, when ports failover.

```
failover_mode: switch;
```

Next, you can set `VRRP_msg_rate` and default priority. `VRRP_msg_rate` is the time in milliseconds between `vrrp` message transmissions over the interconnect link. The `vrrp_def_priority` is the default priority for both switches. The value is set to 254 and should not require change.

```
vrrp_msg_rate: 100;  # In milliseconds

vrrp_def_priority: 254;
```

The following optional entries provide a mechanism to propagate files and/or startup scripts to sibling switches. An example might be startup scripts or scripts to configure gated. Example scripts are included to start gated with RIP1, RIP2, or OSPF setup. You must use absolute path names.

```
  # start_script:  Allows the user to add files and scripts that
are moved

  # to the slave switches when they do a zspconfig -u.  An
example might

  # be the gated configuration script S55...   Absolute path
names are

  # required.  Multiple start_script commands can be used to move
more than

  # one file.
```

```
#start_script:/etc/rcZ.d/SxxScript;

#start_script:/etc/rcZ.d/SyyScript;

  # vrrpd_script:  Allows the user to add scripts to be executed
during

  # vrrpd state transitions.  These scripts are run from the end
of the

  # /etc/rcZ.d/surviving_partner/vrrpd.script file.  The user
provided

  # script must be well behaved.  If it crashes, or hangs or
delays it will

  # effect the SurvivingPartner performance.  The script is not
run in

  # backround.  If this is needed, have your script background
itself.

#vrrpd_script: /etc/rcZ.d/surviving_partner/my_vrrpd_script;

#vrrpd_script: /etc/rcZ.d/surviving_partner/my_vrrpd_script2;

  # gated_template:  Allows the user to provide a template for
the

  # gated.conf file to be used by the sibling group.

#gated_template: /etc/rcZ.d/surviving_partner/gated.template
```

These entries are optional:

If you use the special failover modes *vlan* or *port* (see above for details), you can also specify an individual address to be the default master, that is, that a port or VLAN should run on a specific switch when the `vrrp` priorities are equal between switches.

NOTE: VLAN or port mastering is not appropriate for switch mode and should not be attempted.

When addresses designated 'master' failover, they will return to their Master switch, whenever the link is repaired. If they are not designated 'master', they will remain at the backup switch after repairs.

If both switches are equal in priority for a VLAN, then the switch with theIPaddress designated 'master' will become Master for that VLAN.

Add the keyword “(master)” after one of the sibling_addresses. The local address comes first.

```
        sibling_addresses: zhp1=10.0.0.30(master), 10.0.0.31
   netmask 255.0.0.0;
```

Once the configuration files are complete, run the `zspconfig` utility on the Master to configure all the scripts:

NOTE: This command can take 60 seconds or more with no screen output.

```
zspconfig –f zsp.conf
```

You will see output similar to this:

```
zspconfig -f zsp.conf
….
Would you like to install the Surviving Partner startup
script[y,n,?] y
Would you like to start the Surviving Partner daemons without
rebooting [y,n,?] y
```

Once configuration is complete, insure there are no superfluous S-type startup scripts in `/etc/rcZ.d`, and `zsync` your switch to save your configuration.

Now go to the backup switch and run `zspconfig –u` to get the appropriate configuration information from the Master,

```
zspconfig –u zhp0
```

Modifying zsp_vlan.conf on the Fabric Switch

An example file for setting up `zspconfig` on a Ethernet Switch Blade Fabric board is `/etc/rcZ.d/surviving_partner/zsp_vlan.conf`. Reference the descriptions in the previous section for descriptions of each configuration section.

```
  # Sample configuration is based on the idea that there are
separate VLANs
  # for the multiple connections to a slot.
  #
  #     zhp0: Interconnect VLAN
  #     zhp1..4: Data interface VLANs, configured such that
Option 2
  #     slots have 2 VLANs connected to them and Option 3 slots
have
  #     4 VLANs connected to them.
  #
```

```
  # This script will likely need modification for your particular
  # network setup.
  #
  # In this example the Egress ports, zre20..23 and zre48..50 are
  # not managed by HA since how, or if, these ports are managed
by HA is
  # dependent on the external devices they are connected to.
Non-HA
  # egress ports can be brought up through conventional means by
adding
  # an S-script to /etc/rcZ.d.  If the ports are to be managed by
HA, they
  # can be added to an existing VLAN(zhp) or a new VLAN(zhp) can
be created
  # If a new VLAN(zhp) is to be managed by HA, add a zconfig,
sibling_address,
  # and vrrp_virtual_address configuration line and define the
port type as
  # appropriate.
  #
  # The interconnect port is needed in the VLANs connected to the
  # RAINlink ports.
  #


zconfig zhp0: vlan100 = zre51;


zconfig zhp1: vlan1 = zre0, zre4, zre8, zre12, zre16, zre24,
zre28, zre30, zre32, zre34, zre36, zre38, zre40, zre42, zre51;

zconfig zhp2: vlan2 = zre1, zre5, zre9, zre13, zre17, zre25,
zre29, zre31, zre33, zre35, zre37, zre39, zre41, zre43, zre51;

zconfig zhp3: vlan3 = zre2, zre6, zre10, zre14, zre18, zre26,
zre51;

zconfig zhp4: vlan4 = zre3, zre7, zre11, zre15, zre19, zre27,
zre51;
```

```
zconfig zre0, zre4, zre8, zre12, zre16, zre24, zre28, zre30,
zre32, zre34, zre36, zre38, zre40, zre42 = untag1;

zconfig zre1, zre5, zre9, zre13, zre17, zre25, zre29, zre31,
zre33, zre35, zre37, zre39, zre41, zre43 = untag2;

zconfig zre2, zre6, zre10, zre14, zre18, zre26 = untag3;

zconfig zre3, zre7, zre11, zre15, zre19, zre27 = untag4;

zconfig zre51 = untag100;


  # Recommend using vrrp_mode RAINlink_xmit_on_failover.


zl3d zhp1 zhp2 zhp3 zhp4;


  # First address is our address.  The remaining addresses

  # are handed out to the siblings on a first come first serve

  # basis in the order specified.  Each zconfig'ured interface

  # should have sibling addresses specified.


sibling_addresses: zhp0 = 100.0.0.30, 100.0.0.31 netmask
255.0.0.0;

sibling_addresses: zhp1 = 10.0.0.30, 10.0.0.31 netmask 255.0.0.0;

sibling_addresses: zhp2 = 11.0.0.30, 11.0.0.31 netmask 255.0.0.0;

sibling_addresses: zhp3 = 12.0.0.30, 12.0.0.31 netmask 255.0.0.0;

sibling_addresses: zhp4 = 13.0.0.30, 13.0.0.31 netmask 255.0.0.0;


  # The virtual address spans the sibling group, giving hosts and
routers

  # a single point to connect to or a single point to use as a
router. A

  # virtual address should not be specified for the interconnect
interface.
```

```
vrrp_virtual_address: zhp1 = 10.0.0.42 netmask 255.0.0.0;

vrrp_virtual_address: zhp2 = 11.0.0.42 netmask 255.0.0.0;

vrrp_virtual_address: zhp3 = 12.0.0.42 netmask 255.0.0.0;

vrrp_virtual_address: zhp4 = 13.0.0.42 netmask 255.0.0.0;


  # Port definitions

  # Define to what the ports are connected.  Specifications can
be

  # by zhp or zre name.  The zhp name is a shortcut to specify
the

  # entire port group associated with that interface.  In the end

  # these definitions are on a port by port basis. Note: zhp and

  # zre names cannot be mixed on the same line.

  #

  # Shelf manager ports should be defined as monitor_only.
monitor_only ports

  # are used in failover calculations, but the failover mechanism
is left

  # to the software running on the shelf managers cards.  The use
of the

  # term "crossconnect" in these HA scripts is not the same as
the use

  # in ATCA shelf managers.


interconnect: zhp0;

RAINlink: zre0..19, zre24..43;


############################  Special Modes
############################


  # VRRP modes

  # The block_crossconnect mode causes the equivalent of STP
blocking on the
```

```
  # crossconnect ports of the VRRP Backup.  The
block_crossconnect mode is

  # meant as a replacement for STP, however, the switches
connected to the

  # crossconnect ports must be Ethernet Switch  switches running
Surviving Partner.

  #

  # The RAINlink_xmit_on_failover mode requires that the OpenNode
blades

  # connected to RAINlink ports transmit a packet when failing
over, so that

  # The Layer 2 tables will learn the new port/MACaddress
relationship.  An

  # example is the SNAP_BCAST_MODE in RAINlink or a gratuitous
ARP.


vrrp_mode: RAINlink_xmit_on_failover;

#vrrp_mode: block_crossconnect;


  # failover modes

  # switch-failover, VLAN-failover or port-failover are mutually
exlusive.  They

  # describe what occurs if a port fails.  For switch-failover,
if any port

  # fails, all functionality of the current switch is moved to
the backup

  # For vlan-failover, if a port fails in the vlan then all the
ports that

  # are a member of that VLAN are failed over.   For port-
failover, each port

  # can failover independently.  For vlan and port failover the

  # interconnect will need to be used to maintain connectivity,
requiring

  # all VLANs to include the interconnect ports.
```

```
failover_mode: port;


  # VRRP_msg_rate is the time in milliseconds between
transmissions

  # VRRP messages on the interconnect.  The VRRP protocol
requires the

  # absence of 3 VRRP messages before concluding that the remote
switch

  # has failed.  The msg_rate must match the msg_rate of all
siblings.

  # Anything other than multiples of seconds is non-conformant

  # with the VRRP specification and will only run with ZNYX
supplied

  # vrrpd.


vrrp_msg_rate: 100;  # In milliseconds

vrrp_def_priority: 254;


  # start_script:  Allows the user to add files and scripts that
are moved

  # to the slave switches when they do a zspconfig -u.  An
example might

  # be the gated configuration script S55...   Absolute path
names are

  # required.  Multiple start_script commands can be used to move
more than

  # one file.


#start_script:/etc/rcZ.d/SxxScript;

#start_script:/etc/rcZ.d/SyyScript;


  # board_synchronization_mode:  Coordinate the HA events between
the Base and
```

```
  # Fabric portions of the 7100 switch.  The actual coordination
is dependent on the

  # setting of the board_synchronization_mode and the
failover_mode.  In

  # switch failover_mode the number of up links in both switch
planes is

  # considered.  In vlan and port failover mode they are not.  In
all

  # failover_modes, if the data plane or fabric plane switch
reboots or

  # power cycles, the HA partner will take mastership for all
VLANs in

  # both planes.  board_synchronization is off by default.
"basic" is the

  # only supported mode at this time.  The same mode must be set
in both

  # the base and fabric switches.


#board_synchronization_mode: basic;


  # vrrpd_script:  Allows the user to add scripts to be executed
during

  # vrrpd state transitions.  These scripts are run from the end
of the

  # /etc/rcZ.d/surviving_partner/vrrpd.script file.  The user
provided

  # script must be well behaved.  If it crashes, or hangs or
delays it will

  # effect the SurvivingPartner performance.  The script is not
run in

  # backround.  If this is needed, have your script background
itself.


#vrrpd_script: /etc/rcZ.d/surviving_partner/my_vrrpd_script;

#vrrpd_script: /etc/rcZ.d/surviving_partner/my_vrrpd_script2;
```

```
  # gated_template:  Allows the user to provide a template for
the
  # gated.conf file to be used by the sibling group.


#gated_template: /etc/rcZ.d/surviving_partner/gated.template
```

Once the configuration files are complete, run the `zspconfig` utility on the Master to configure all the scripts:

NOTE: This command can take 60 seconds or more with no screen output.

```
zspconfig –f zsp.conf
```

You will see output similar to this:

```
zspconfig -f zsp.conf
….
Would you like to install the Surviving Partner startup
script[y,n,?] y
Would you like to start the Surviving Partner daemons without
rebooting [y,n,?] y
```

Once configuration is complete, insure there are no superfluous S-type startup scripts in `/etc/rcZ.d`, and `zsync` your switch to save your configuration.

Now go to the backup switch and run `zspconfig –u` to get the appropriate configuration information from the Master,

```
zspconfig –u zhp0
```

Configuring Surviving Partner

The `S60SP_startup` script is useful in setting up proper switch replacement. By factory installing the `S60SP_startup` script in replacement switches, the replacement switches will boot looking for a Master switch configuration. The `S60SP_startup` works as follows:

It first looks for a local file `/etc/rcZ.d/surviving_partner/zsp.primary.conf`. If this file exists, it is used to configure the switch. Only the originally configured switch or Central Authority should contain this file. See Central Authority later in this Chapter for more information.

Next it uses `zspconfig –u` to attempt to contact a running Master switch to retrieve the proper configuration. This is the normal case for a replacement switch.

Finally, it lets the currently saved `S70Surviving_Partner` script execute. This case would be the case of a power up of an already configured backup switch when the other HA switch is unavailable. This case could occur after losing power to the entire chassis.

Central Authority

Modifications can be made to the `S60SP_startup` script to use a third machine running DHCP that is not part of the Surviving Partner pair. The third machine is referred to as the Central Authority.

Setup requires a DHCP daemon configuration file on the Central Authority and a `dhclient` configuration file for each of the two Surviving Partner switches in the pair. The format of the DHCP daemon configuration file is dependent on the machine and operating system being used. An example can be obtained from the Surviving Partner primary switch in the location `/etc/rcZ.d/surviving_partner/dhcpd.conf`.

This configuration will contain configuration for only one of the two Surviving Partner switches. It must be edited. For example:

```
subnet 100.0.0.0 netmask 255.0.0.0 {
            option broadcast-address 100.255.255.255;

            host ZNYX1 {
                        fixed-address 100.0.0.31;
                        option dhcp-client-identifier "ZNYX";
                        option vendor-encapsulated-options
"zsp_conf.1";
            }
}
```

A second host entry must be added with unique information.

```
subnet 100.0.0.0 netmask 255.0.0.0 {
            option broadcast-address 100.255.255.255;

            host PRIMARY {
                        fixed-address 100.0.0.30;
                        option dhcp-client-identifier "PRIMARY";
                        option vendor-encapsulated-options
```

```
"zsp.primary.conf";
            }
            host SECONDARY {
                        fixed-address 100.0.0.31;
                        option dhcp-client-identifier
"SECONDARY";
                        option vendor-encapsulated-options
"zsp.secondary.conf";
            }
}
```

The `zsp.primary.conf and zsp.secondary.conf` files must be placed in the `tftp` location on the machine, often `/tftpboot`. The `zsp.primary.conf and zsp.secondary.conf` files can be retrieved from the Surviving Partner switches. This is the configuration that will be given to the switches. It is recommended that the `zsp.conf` be taken from the primary as follows:

The `zsp.conf` file created by hand on the primary is moved to `/tftpboot/zsp.primary.conf` on the Central Authority.

Move `/tftpboot/zsp_DC.conf.1` file on the primary created by `zspconfig` to `/tftpboot/zsp.secondary.conf` on the Central Authority.

Create `dhclient.conf` files on the Surviving Partner switches. Examples can be found in `/etc/rcZ.d/surviving_partner/dhclient.conf`. As an example:

```
send dhcp-client-identifier "ZNYX";
request vendor-encapsulated-options;
require vendor-encapsulated-options;
```

Modify the `dhclient.conf` file on the primary switch as follows:

```
send dhcp-client-identifier "PRIMARY";
request vendor-encapsulated-options;
require vendor-encapsulated-options;
```

Modify the `dhclient.conf` file on the secondary switch as follows:

```
send dhcp-client-identifier "SECONDARY";
```

```
request vendor-encapsulated-options;

require vendor-encapsulated-options;
```

The last step is to modify the startup scripts that run `zspconfig` to use the `-c` option. The `-c` option allows you to provide a `dhclient.conf` script rather then having `zspconfig` create a default. For example, the `S60SP_startup` script line that reads:

```
echo  y n | zspconfig -t 10 -su zhp0 > /dev/null 2>&1
```

Can be modified to

```
echo  y n | zspconfig -c
/etc/rcZ.d/surviving_partner/dhclient.new.conf -t 10 -su zhp0
> /dev/null 2>&1
```

If you use `S60SP_startup`, the `/etc/rcZ.d/surviving_partner/zsp.primary.conf` file should not exist. This way the `S60SP_startup` script will first look at the Central Authority. If the Central Authority is down, then it will use its current configuration.

Chapter 4 Fabric Switch Configuration

Two switches, two consoles

There are two separate switch portions in the Ethernet Switch Blade units, the base switch and the fabric switch. The fabric switch handles the data traffic for the ATCA rack over ports 0-47. It runs the Ethernet Switch Blade software. Two or four GigE connections are provided to node cards using the ATCA backplane.

Connecting to the Fabric Switch Console

You can connect to the fabric switch console using a `telnet` connection or with a console cable. Use the procedure below for a `telnet` connection. See Connecting to the Console Port, for instructions.

Connect an Ethernet cable to the host and the switch. The OOB port is not active in the default configuration. You can connect to the fabric OOB port on the front panel.

Work from a host on the 10.0.0.0 network.

The OpenArchitect switch is pre-configured with address 10.0.0.43. Telnet to 10.0.0.43.

```
telnet 10.0.0.43
```

After you are connected, enter the login name root. No password is required.

```
OpenArchitect login: root
ZX7100-OA<release no.>#
```

OpenArchitect Configuration Procedure

Layer 2 and Layer 3 switch configurations can be accomplished with a few simple commands. Once you have configured your switch, the commands should be placed into a start up configuration script. Like most Linux systems, the OpenArchitect switch boot process runs initialization commands and scripts in `/etc/init.d/`. In particular, OpenArchitect runs `/etc/init.d/rcS` which in turn executes all scripts located in `/etc/rcZ.d` starting with an uppercase “S” in alphabetical order. Any configuration scripts you create should be named in the standard Linux/Unix manner, starting with an uppercase “S” and numbered in the sequence you would like them executed. The final step once the switch has been properly configured is to use the `zsync` command to save all files into flash for reloading.

Changing the Shell Prompt

You may use standard bash shell procedures to change the prompts on your base switches. Many sites choose a system that distinguishes among the individual switches at their location. The same rules apply for saving your choice (`zsync`) as for all other configuration changes.

Default Configuration Scripts

As shipped the following scripts are run from `/etc/rcZ.d` as the switch boots up:

NOTE: These default scripts will change in later releases. Use them as examples.

S20stack - Script that calls `zstack` to combine the two BCM56504 24-port switch fabric chips into a single 48 port virtual switch. `zstack` must be run before any other switch configuration.

S50layer2 - Script that sets up a basic Layer 2 switch. All 48 ports are set up on one VLAN. This configuration script is appropriate for a Ethernet Switch Blade. It may need to be modified for other models.

Example Configuration Scripts

Example scripts are provided that can be used as templates. Use one of the scripts located in the switch `/etc/rcZ.d/examples` directory to help you configure the switch. The default configuration for the switch is located in the script file `/etc/rcZ.d/S50layer2`.

The following scripts are included (each is examined in more detail later in the appropriate section describing common Layer 2 and Layer 3 configurations):

- S50layer2 - Script which sets up a basic Layer 2 switch. All 48 ports are set up on one VLAN. This is a copy of the script in `/etc/rcZ.d` that is loaded in the default configuration.
- S50layer3 - Script which sets up a basic Layer 3 switch. All 48 ports are set up on individual IP networks (VLANs). Layer 3 switching is enabled.
- S50multivlan - Script which sets up multiple untagged VLANs. (See Using the S50layer3 Script) Layer 3 switching is enabled.
- S55gatedRip1 - Script which is used with a Layer 3 switch and calls the GateD daemon to enable RIP 1 routing protocol.
- S55gatedRip2 - Script which is used with a Layer 3 switch and calls the GateD daemon to enable RIP 2 routing protocol.
- S55gatedOspf - Script which is used with a Layer 3 switch and calls the GateD daemon to enable OSPF routing protocol.

Overview of OpenArchitect VLAN Interfaces

A `zhp` device is associated with one VLAN. `zhp` may have one or more physical ports and their associated `zre` devices. A VLAN from the viewpoint of the switch is a logical mapping of ports based on intended use. The primary purpose of a VLAN is to isolate traffic and enable communication to flow more efficiently within groups of mutual interest. The switch is used to bridge from one VLAN to another. Figure 4.1: Fabric VLANs is an example of a custom layer2 VLAN network structure in a fabric switch.

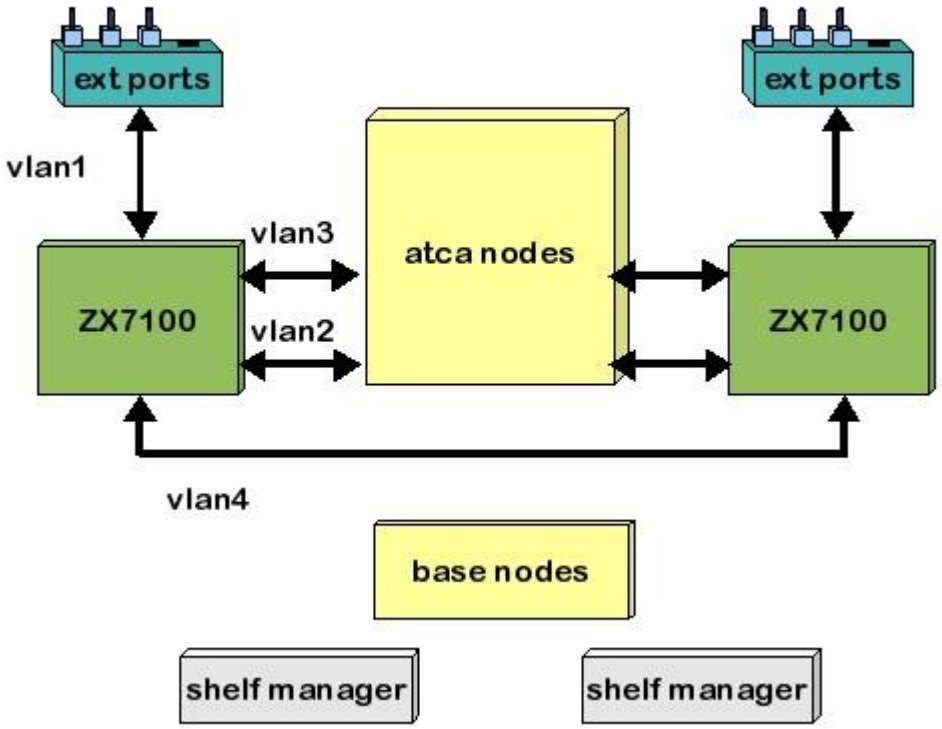


Figure 4.1: Fabric VLANs

In the Figure 4.1, four VLANs for each fabric switch are used to organize traffic. This is just one example of how a layer 2 switch could be configured with the fabric switch.

Tagging and Untagging VLANs

The OpenArchitect switch is capable of switching VLAN tagged and untagged data packets. VLAN tagged packets conform to the 802.1q specification and the packet header contains an additional four bytes of VLAN tag information. A given port can be specified to accept VLAN tagged or untagged traffic. Internally, all traffic for a particular VLAN is treated as tagged traffic.

Switch Port Interfaces

For each switch port, OpenArchitect creates a separate interface with its own MAC address called a ZNYX raw Ethernet (`zre`). After the initial power up, 48 `zre` interfaces are created, one for each in band port. You cannot directly access or modify the `zre` interfaces.

During the initial power up of the switch, the default configuration creates a Layer 2 switch. The Layer 2 configuration places the `zre` interfaces in one `zhp` interface. See Figure 4.1: Fabric VLANs The number after `zre` represents the corresponding switch port number (that is, `zre1` represents port 1 on the switch).

Layer 2 Switch Configuration

The steps to build a Layer 2 switch involve creating groups of switch ports in VLANs (Layer 2 switching domains) and bringing the interfaces up. `zconfig` creates the VLAN group of switch ports as well as a network interface. Use `ifconfig(1M)` on the network interface to bring up the VLAN group.

A startup script called `/etc/rcZ.d/S50layer2` is executed at boot time creating one untagged VLAN (`zhp0`) for all ports. The ISL is assigned its own VLAN. The interface to the host is then assigned the IP address of 10.0.0.43 to allow access to the switch. The VLAN is assigned an IP address. The `S50layer2` script does the following:

```
## Create a single untagged vlan (i.e. interface), consisting
# of the 48 Gigabit Ethernet ports Layer 2 forwarding enabled
# Put the ISL in its own vlan to avoid loops
#
/usr/sbin/zconfig zhp0: vlan1=zre0..50
/usr/sbin/zconfig zre0..50=untag1
/usr/sbin/zconfig zhp1: vlan2=zre51
/usr/sbin/zconfig zre51=untag2
sleep 1
#
# Assign the ZNYX default IP address 10.0.0.43 to the
# zhp0 interface and start it
#
ifconfig zhp0 10.0.0.43 netmask 255.255.255.0 broadcast
10.0.0.255 up
```

```
ifconfig zhp1 0.0.0.0
#
# At this point the system will act as a Layer 2 switch
# across all ports. Also, the system will accept telnet()
# connections on 10.0.0.43 on any port.  Script(s) may then
# be run to reinitialize the system and modify its
# configuration.
```

Using the S50layer2 Script

The `S50layer2` script can be used as an example, and edited to customize your Layer2 setup. The default script may not match your physical port configuration. In that case you will have to alter the script to suit your circumstances. For example, to reconfigure the IP address on your Layer 2 switch**,**

Open the `S50layer2` file in the Linux *vi* editor.

Change the IP address value listed under the Linux `ifconfig(1M)` command line.

Save your changes by running OpenArchitect `zsync`.

```
zsync
```

Reboot the switch.

Rapid Spanning Tree

The Rapid Spanning Tree Protocol (RSTP) configures a simply connected active topology from the arbitrarily connected components of a Bridged Local Area Network. RSTP participants use a simple dialog carried in packets called Bridge Protocol Data Units (BPDUs) for finding the shortest path between two networks and for eliminating loops from the topology. If nodes attached to ports fail or are added or deleted, the topology dynamically changes to accommodate the new configuration. If your network topology is such that there is no real redundancy or chance for loops, you do not need to turn on Spanning Tree.

`zl2d` is a shell script used to create Linux bridges consisting of the name of the previously created `zhp` device or devices preceded with a "b" (for example, if you are creating a Bridge device from `zhp0`, the resulting device would be `bzhp0`). `zl2d` then starts a background task that monitors the port information of the Linux bridge at a specified interval and updates the Spanning Tree state fields in the hardware when necessary.

`brctl(8)` is called by `zl2d` for configuring certain RSTP parameters. For an explanation of these parameters, see the IEEE 802.1d specification, or reference the `brctl(8)` man page in Appendix A. The following demonstrates a simple example of setting up a Layer 2 switch and starting RSTP.

To Enable Rapid Spanning Tree:

Create a VLAN containing the ports that will be a part of the Linux bridge running Rapid Spanning Tree. This example will use ports 0-3 (untagged):

```
zconfig zhp0: vlan1=zre0..3
zconfig zre0..3=untag1
```

Create a bridge device from the `zhp` device,

```
zl2d start zhp0
```

A Bridge device named `bzhp0` should now exist consisting of ports `zre0` through `zre3` with Spanning Tree enabled. To view the bridge device, use the `brctl` command,

```
brctl show
brctl showbr bzhp0
```

Port Path Cost

Each port has an associated cost that contributes to the total cost of the path to the Root Bridge when the port is the root port. The smaller the cost, the better the path. The Ethernet Switch Blade uses the following IEEE 802.1D recommendations based on the connection speed of your port:

Port Path Cost		
Link Speed	**Recommended Value**	**Recommended Range**
10 Mb/s	100	50-600
100 Mb/s	19	10-60
1 Gb/s	4	3-10
10 Gb/s	TBD	TBD

To change the port path, use the `brctl setpathcost` option. For example, to set the port priority to a value consistent with a gigabit interface,

```
brctl setpathcost bzhp0 zre1 4
```

Layer 3 Switch Configuration

The previous section outlines the Layer 2 switch configuration that is automatically configured when you initially bring up the OpenArchitect switch. In order to communicate between Layer2 interfaces, you must properly setup routing.

The steps to build a Layer 2 switch involve creating a group of switch ports in a VLAN (or Layer 2 switching domain) and bringing that interface up. `zconfig` creates the VLAN group of switch ports as well as a network interface. Use `ifconfig(1M)` on the network interface to bring up the VLAN group with Layer 2 switching. Layer 3 routing information is then used to route between the Layer 2 network devices.

Take a simple example of two VLANs configured on the switch, each with four ports. First teardown any existing configuration,

```
zconfig –t
```

Use `zconfig` to create two new VLANs, each with four ports, and untag them,

```
zconfig zhp0: vlan1=zre1..4

zconfig zre1..4=untag1
zconfig zhp1: vlan2=zre5..8

zconfig zre5..8=untag2
```

Now, use `ifconfig` to assign each `zhp` interface an IP address,

```
ifconfig zhp0 10.0.0.1

ifconfig zhp1 11.0.0.1
```

At this point, the Linux host has enough information to route between the networks of the directly attached interfaces, 10.0.0.0 via `zhp0`, and 11.0.0.0 via `zhp1`.

The next step is to enable the `zl3d` daemon to move that routing information from the host to the Ethernet Switch Blade switching tables in silicon. Once enabled, `zl3d` will monitor the Linux routing tables for changes in configuration and update the switch silicon tables. Start `zl3d` to update the switch tables:

```
zl3d zhp0 zhp1
```

The Ethernet Switch Blade switch is now configured as a Layer3 switch that can route between two Layer2 devices in silicon.

Using the S50layer3 Script

To modify the configuration to a Layer 3 switch, remove the `S50layer2` file from the `/etc/rcZ.d` directory, and replace it with the example script file, `S50layer3`.

In the S50layer3 script separate VLANs are set up for each port. The VLANs, are labeled as zhp0..zhpn. Each VLAN is associated with an individual zre interface. There is always a one to one connection between VLANs and zhp interfaces. Remember, zre and zhp interfaces can begin with a zero value but a VLAN cannot (that is, zhp0 has zre0 on vlan1, zhp1 has zre1 on vlan2). Each zhp interface is assigned a separate IP address in the example script.

The S50layer3 script executes the following commands:

- Runs zconfig command to create 48 untagged VLANs (one for each switch port).

```
/usr/sbin/zconfig zhp0..47: vlan1..48=zre0+

/usr/sbin/zconfig zre0..47=untag1+
```

NOTE : Double periods (..) after vlan1 and untag1 are used to indicate a range of values. The plus (+) sign after zre1 is a wildcard character that means auto-incremented and causes each zhp interface to hold only one zre (that is, zhp0 has zre1 on vlan1, zhp1 has zre1 on vlan2).

Runs the Linux ifconfig(1M) command for each interface to assign default IP addresses (10.0.0.43-10.0.47.43), sets the netmask and brings up the interfaces.

```
ifconfig zhp0 10.0.00.42 netmask 255.255.255.0 up

ifconfig zhp1 10.0.01.42 netmask 255.255.255.0 up

ifconfig zhp2 10.0.02.42 netmask 255.255.255.0 up

.

.

.

ifconfig zhp21 10.0.45.42 netmask 255.255.255.0 up

ifconfig zhp22 10.0.46.42 netmask 255.255.255.0 up

ifconfig zhp23 10.0.47.42 netmask 255.255.255.0 up
```

- Runs the OpenArchitect zl3d. The zl3d application monitors the Linux routing tables and updates the switch routing tables for each interface configured above.

```
/usr/sbin/zl3d zhp0..47
```

zl3d initially creates and adds each zhp interface (VLAN) to the switch routing tables. The zhp0..zhp47 is shorthand for the list of interfaces (zhp0, zhp1, …, zhp47) to monitor with zl3d.

To Modify the Layer 3 Script

- Modify the example script you copied into the /etc/rcZ.d directory. Adjust and assign

the number of IP addresses as applicable. In the example below, the IP address is changed for the interface in the `ifconfig` command line of the script.

From:

```
ifconfig zhp0 10.0.0.43 netmask 255.255.255.0 broadcast
10.0.0.255 up
```

To:

```
ifconfig zhp0 193.08.1.1 netmask 255.255.255.0 broadcast
193.08.1.255 up
```

- Adjust the number of `zhp` interfaces, that are added to the routing tables, depending on the number of VLANs you are adding for your network. Include any other details, as applicable.

- Run the OpenArchitect `zsync` command to save your changes.

```
zsync
```

- Reboot the switch.
- After rebooting, your switch works from your customized Layer 3 configuration.

Layer 3 Routing Protocols with GateD

An advanced networking configuration may require using the GateD software platform for deployment of Routing Information Protocols (RIP 1 or RIP 2) and Open Shortest Path First (OSPF) protocols. Once you've configured your Layer2 and Layer3 devices, start `gated`.

Using the S55gatedRip1 Script

To use GateD protocol with the switch, you need to copy two files into the same directory as your Layer 3 configuration file. From the `/etc/rcZ.d/examples` folder, copy the example script file and its corresponding GateD configuration file (for example, `S55gatedRip1` and `gated.conf.rip1`).

The example startup script executes the following commands (`S55gatedRip1` is used as an example):

- Starts GateD with Rip1 using `gated.conf.rip1` as the configuration file:

```
/usr/sbin/gated –f /etc/rcZ.d/gated.conf.rip1
```

The GateD `conf` file specifies the following configuration commands:

- Implements the passive function so GateD is prevented from rerouting information to a different interface if insufficient information is received.

```
interface 10.0.0.43 passive
```

```
interface 10.0.1.42 passive
interface 10.0.2.42 passive
.
.
.
interface 10.0.13.42 passive
interface 10.0.14.42 passive
interface 10.0.15.42 passive
```

- Defines the netmask used in the interface.

```
define 10.0.0.43 netmask 255.255.255.0;
define 10.0.1.42 netmask 255.255.255.0;
define 10.0.2.42 netmask 255.255.255.0;
.
.
.
define 10.0.13.42 netmask 255.255.255.0;
define 10.0.14.42 netmask 255.255.255.0;
define 10.0.15.42 netmask 255.255.255.0;
```

- Sets the RIP1 protocol to open.

```
};
rip1 yes{
```

- Shuts off sending and receiving packets from all interfaces.

```
interface all noripin noripout
```

- Opens sending and receiving packets for selected interfaces.

```
interface 10.0.0.43 ripin ripout version 1;
interface 10.0.1.43 ripin ripout version 1;
interface 10.0.2.43 ripin ripout version 1;
.
```

```
.
.
interface 10.0.13.43 ripin ripout version 1;
interface 10.0.14.43 ripin ripout version 1;
interface 10.0.15.43 ripin ripout version 1;
```

- Imports routes learned through the RIP protocol.

```
import proto rip {
        all;
};
```

- Exports all directly connected routes and routes learned from the RIP protocol.

```
export proto rip {
       proto direct }
        all;
};
proto rip {
      all;
};
```

To Modify the GateD Scripts:

Copy two GateD files, the OpenArchitect "S" file and its corresponding conf file, into the rcZ.d directory (that is, S55gatedRip1 and gated.conf.rip1). Notice the files are placed in the same directory as the Layer 3 configuration file.

For RIP1:

```
cp /etc/rcZ.d/examples/S55gatedRip1 /etc/rcZ.d
cp /etc/rcZ.d/examples/gated.conf.rip1 /etc/rcZ.d
```

Or for RIP2:

```
cp /etc/rcZ.d/examples/S55gatedRip2 /etc/rcZ.d
cp /etc/rcZ.d/examples/gated.conf.rip2 /etc/rcZ.d
```

Or for OSPF:

```
cp /etc/rcZ.d/examples/S55gatedOspf /etc/rcZ.d

cp /etc/rcZ.d/examples/gated.conf.ospf /etc/rcZ.d
```

- Open and make configuration changes to the listed `conf` file to coincide with the current Layer 3 configuration (that is, adjust IP addresses and number of interfaces available). See GateD documentation if you have questions regarding the `conf` file.
- Run the OpenArchitect `zsync` command to save your changes. Be sure your changes are correct:

```
Zsync
```

- Reboot the switch. After rebooting, your switch operates as a Layer 3 switch with GateD routing.

Class of Service (COS)

This following section provides information on using the OpenArchitect switch to provide Class of Service (COS) support. The switching fabric architecture defines the scope of the COS parameters. Some apply to an individual port, and others apply to the whole switch. It is important for the user to understand the scope of the parameters to ensure that the expected behavior occurs.

Egress Queues

The Ethernet Switch Blade fabric switch provides 1 to 8 COS queues per egress port, and for packets destined to the CPU from the switching fabric. By default, a freshly booted OpenArchitect switch has a single queue per egress port (and the CPU).

Ingress Classification

Incoming packets are mapped to queues based on their priority tags. The built-in behavior of the Ethernet Switch Blade uses the 802.1p tag within a packet as the queue selector. There is one COS to queue selector map per port.

By using the Linux `iptables` utility and `zfilterd` with `ztmd`, the queue selection can be based on any information in the first 64 bytes of the IP packet header. The default OpenArchitect switch behavior has all COS values mapping to a single queue on each of the egress ports.

A default priority for an untagged packet can be assigned for each port. By default, these incoming priority values are all mapped to COS queue 0. To change the default priority for untagged packets, or to define the mapping from priority values to COS queues, use the `zcos` command (refer to Appendix A).

Marking and Re-marking

The OpenArchitect switch can mark or remark packets using the TOS field or 802.1p tag. This is also controlled through the Linux `iptables` utility.

Scheduling

The servicing of configured queues by the switching fabric is referred to as scheduling. The OpenArchitect switch has three built-in scheduling algorithms. The type of scheduling algorithm used is implied, rather than being explicitly specified, based on the number of queues and which options are configured. The following scheduling algorithms are provided:

First In First Out (FIFO) – When only one queue is configured per port, packets are serviced in the order in which they arrive. This is the default for the OpenArchitect switch.

Strict Priority – This algorithm is used when more than one queue is provisioned on the port. The highest priority queue, which is also the highest numbered one, is always serviced first (Example: If four queues are configured, queue three is of higher priority than queue zero). As long as there are packets in the highest priority queue, the lower priority queues are not serviced. The danger is that higher priority traffic could block lower priority traffic.

Weighted Round Robin (WRR) – This algorithm is similar to Strict Priority scheduling, but it provides fairness with quanta for each queue. Each queue is assigned a number of packets, known as *weight*, that it is allowed to transmit before it yields to a lower priority queue. Note that with WRR, the priorities of the queues are dependent on the weights allocated. A higher priority queue with a smaller weight will get less wire-time than a lower priority queue configured with a larger weight. The relative weights used for priority queues on a port can be set using the `zcos` command (this is a switch-wide parameter).

`ztmd` Explained

`ztmd` is a traffic management daemon which accepts messages from traffic filtering and quality of service applications and sets up the hardware.

`zfilterd` Explained

`zfilterd` is a daemon that intercepts filtering rules entered by the user via `iptables`, checks them for validity and then passes them on to `ztmd` for entry in the switch.

Running `zfilterd`

Before starting `zfilterd`, `ztmd` must be running. Your can start both from within a script, or directly from the command line. For example,

```
ztmd
zfilterd
```

`iptables` rules can be entered at any time. If your `iptables` filtering rules set is extensive,

you may want to move your set of `iptables` commands to a start up script to run upon initialization. This could be accomplished by creating a standalone "`S`" script and placing that script into /`etc/rcZ.d`.

Restrictions on Implementation

Several restrictions exist on the rules that can be implemented on the FFP hardware. These include:

Actions
DROP the packet. ACCEPT the packet.

Output Port
Should be specified if the action is ACCEPT, if no output port is specified, an IRULE table entry is generated for every port.

Field values
If specified as ranges, they must be on power of two boundaries.

Negation
Can only be used for icmp, tcp, or udp fields.

Fields supported are: Source IP address, destination IP address, IP protocol, TCP or UDP source port or destination port, ICMP type, and TCP flags bits (such as SYN).

The input port and output port may also be specified as either `zre<n>`, where `<n>` is one of the 48 physical ports, or as `zhp<n>`, where the `zhp` interface used must be previously defined using `zconfig`.

A restriction on the fields supported is the size of the IMASK table. There are only 16 entries per port available, which means only 16 combinations of fields can be used at any time.

Conflict Resolution

There are differences from the expected behavior of implementing `iptables` in a host: Although the rules are taken from the FORWARD and INPUT chains, they are applied to all packets, including those destined for the local CPU. The order of application of the rules is not necessarily the order in which they appear in the chains. If a rule uses a mask that is less restrictive than another rule, it will be applied first. The last rule that is matched determines the action that will take place. For example, the rules:

```
            iptables -a FORWARD -i zhp3 -j DROP

            iptables -a FORWARD -i zhp3 -o zhp1 -p tcp --dport
smtp             -j ACCEPT
```

result in SMTP packets received on any port in `zhp3` to be sent for any port in `zhp1`; all other packets from `zhp3` would be dropped. The order of the two rules in the FORWARD chain does not matter.

On the other hand, in the following sequence of rules, the position of the rule that drops SYN packets is important. Since the set of fields it examines is not a subset of the fields examined by the ACCEPT rules, and visa versa, the ordering rule given above does not apply. In this case, the order it is applied will be the same as its position in the FORWARD chain, and all packets which are TCP SYN packets from `zhp5` for `zhp3` will be DROPPED, even if they also match one of the ACCEPT rules.

```
iptables -a FORWARD -i zhp5 -o zhp3 -j DROP

iptables -a FORWARD -i zhp5 -o zhp3 -p tcp --sport smtp -j
ACCEPT

iptables -a FORWARD -i zhp5 -o zhp3 -p udp --sport domain -j
ACCEPT

iptables -a FORWARD -i zhp5 -o zhp3 -p tcp --sport domain -j
ACCEPT

iptables -a FORWARD -i zhp5 -o zhp3 -p tcp --sport www -j
ACCEPT

iptables -a FORWARD -i zhp5 -o zhp3 -p tcp --sport 23 -j
ACCEPT # rsync

iptables -a FORWARD -i zhp5 -o zhp3 -p tcp --syn -j DROP
```

iptables and filtering

`iptables` is a firewall management user-space utility used in conjunction with the Linux 2.4 kernels, and takes advantage of the netfilter 2.4 kernel code. `iptables` is extended with a few more targets to support the hardware filtering functionality used in the chips on the Ethernet Switch Blade (fabric board). Generally, all of the `iptables` functionality is usable with a few minor extensions.

A more detailed source on `iptables` can be found at:

http://www.netfilter.org/

Almost all the contents described here are derived from there.

There are also many tutorials and `iptables` manipulation tools, both graphical and command line. This is expressive of the Open Architect concept. A good place to start is:

http://freshmeat.net/search/?q=iptables

Introduction

Firewall rules are stored in tables. These tables are sometimes also known as *firewall chains* or just *chains*. Tables normally store rules for what are known as *hooks*, which can be looked as packet-path junctions. There are five defined hooks: PRE-ROUTE, POST-ROUTE, INPUT, OUTPUT and FORWARDING. The example below illustrates the default chains on boot up.

By default, INPUT, FORWARD and OUTPUT chains are installed on boot up. Additional rules can be installed for the other chains. Additionally, one can write software extensions to add more chains. Figure 4.2 provides an illustration of the Firewall Flow.

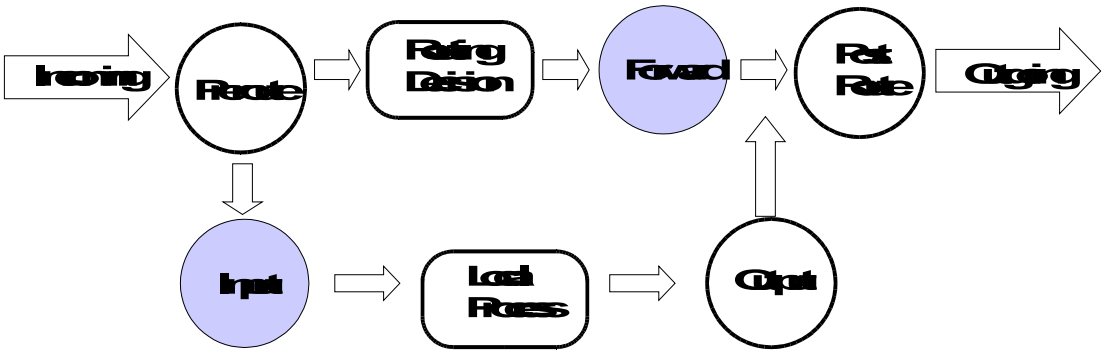


Figure 4.2: Firewall Flow

When a packet reaches a circle in the diagram, that chain is examined to decide the fate of the packet. Two basic fates of a packet are defined as DROP and ACCEPT. If the chain says to DROP the packet, it is killed there; however, if the chain says to ACCEPT the packet, it continues traversing the diagram, ultimately terminating at an application or getting forwarded out of the box. There are additional actions which may be applied to packets. These are described in the "Supported Targets" section.

A chain is a checklist of rules. Each rule is checked against the packet header and if a rule matches, action is taken. If the rule doesn't match the packet, then the next rule in the chain is consulted. Finally, if there are no more rules to consult, then the kernel looks at the chain default policy to decide what to do. In a security-conscious system, this policy usually tells the kernel to DROP the packet.

In the Ethernet Switch Blade product, both the FORWARD chain hook, and the INPUT chain hook (packets destined for the CPU) are implemented in hardware. The rest of the hooks are in software in the Linux kernel. An extension of the FORWARD hook also resides in software. It is important to note that this is in sync with routing being implemented in hardware with software assist for exception handling. Under general circumstances, when routing happens in hardware, only the FORWARD chain is traversed. Under exceptional handling of an incoming packet, one can force the full software traversal. As a router you do not really care about the other hooks except in the situation where you have some special handling, in which case a policy would force the packet to be sent to the CPU for further processing.

NOTE: This is also how one would extend the OA packet munging capabilities (for example, introduce NAT).

Packet Walk

When a packet comes in via one of the interface ports, the Ethernet Switch Blade makes a routing decision. If the packet was destined for the Ethernet Switch Blade fabric switch itself or if the

send to CPU action is specified, it is sent to the INPUT chain for further processing. If there is no valid way to forward the packet, it is dropped. If the switch is configured to forward the packet, it is sent to the FORWARD chain.

Next the hardware FORWARD chain is walked. If there is a rule inserted that matches the packet headers, then it is looked up next. The inserted policy will decide the packets fate.

In essence, a filter rule will be used to scan the packet data for certain characteristics. Upon a match a selected 'target' is executed. The target decides what should happen to the packet.

Filter Rules Specifications

A rule could be added (`-a`) to a chain, deleted (`-D`) from a chain, replaced (`-R`) from a chain or inserted (`-I`) in a specific position in a chain. Each rule specifies a set of conditions the packet must meet, and what to do if it meets them ('what to do' is referred to as a `target').

Here's an example filter rule:

```
iptables -a FORWARD -p UDP -s 0/0 -d 10.0.0.1/32 --source-port
53 -j DROP
```

This adds to the FORWARD chain the rule: "If you see UDP packets (-p UDP) from anywhere (-s 0/0) going to host 10.0.0.1 (-d 10.0.0.1/32) with a source port number 53 (--source-port 53) then the target is to DROP (-j DROP). More details on rule specifications follow.

Specifying Source and Destination IP Addresses

Source (`-s`, `--source` or `--src`) and destination (`-d`, `--destination` or `--dst`) IP addresses can be specified in four ways. The most common way is to use the full name, such as localhost or www.linuxhq.com. The second way is to specify the IP address such as 127.0.0.1.

Netmasks can be applied to IP addresses to specify ranges, like199.95.207.0/24 or 199.95.207.0/255.255.255.0 Both specify any IP address from 199.95.207.0 to 199.95.207.255 inclusive. To specify an all-inclusive IP address `/0` can be used, like: `-s` or `-d 0/0`. The example rule we use above applies this trick. Note however that the effect above is the same as not specifying the `-s` option at all.

Specifying Protocol

The protocol can be specified with the `-p` (or `--protocol`) flag. Protocol can be a number (if you know the numeric protocol values for IP) or a name for the special cases of TCP, UDP or ICMP. Case does not matter, so `tcp` works as well as `TCP`.

Specifying an ICMP Message Type

If the protocol is ICMP, the `--icmp-type` option can be used to match a specific message type, for example, `--icmp-type ping`

The type can be preceded by ! to match any message except the type listed, for example, `--icmp-type ! 1`

Specifying TCP or UDP ports

If the protocol is TCP or UDP, the `-s` (or `--sport`) and `-d` (or `--dport`) options specify the TCP or UDP ports to match.

A range of ports can be specified by giving the first and last ports separated by a `:`, as in `--dport 0:1023`. It is also possible to precede the port specification with a ! to match all ports which are not included in the range, for example, `--sport ! 0:1023`. However, the range of ports must be a power of two, starting with a port number which is a multiple of the range.

Specifying TCP flags

If the protocol is TCP, a match on particular TCP flags is specified by listing the flag names; for example, `-p tcp --syn`.

Specifying an Interface

The `-i` (or `--in-interface`) and `-o` (or `--out-interface`) options specify the name of an interface to match. An interface is the physical device the packet came in on (`-i`) or is going out on (`-o`). You can use the `ifconfig` command to list the `up' interfaces (for example, working at the moment).

As a special case, an interface name ending with a + will match all interfaces, whether they currently exist or not, which begin with that string. For example, to specify a rule which matches all `zhp` interfaces, the `-i zhp+` option would be used.

Filter Rule Targets

As mentioned above the `-j` construct within a rule specifies which target is to be used in filter rule to define a target.

Supported Targets

The following are the supported targets. The switch has many additional targets that are software based (example Network Address Translation or generic connection tracking).

Classical Targets

```
DROP  This drops the packet.

ACCEPT     Accepts the packet
```

ZNYX Targets

ZACTION This is the ZNYX Action target.

Parameters for ZACTION:

```
--drop     Drops the packet

--accept    Accepts the packet

--set-prio <val>Set the 802.1p priority to <val>

--use-prio <val>Use queue priority <val>

--copy-cpu Send the packet to the CPU.  This will force the full
installed chains traversal in software

           --set-eport <val>    Redirect the packet to port <val>

                  --set-mport <val>  Mirror the packet to port
<val>

--set-tos <val> Set the IP-Precedence bits in the TOS field of
the IP header to <val>

--set-dscp <val>Set the 6-bit DSCP  in the TOS field of the IP
header to <val>.
```

Options with any of these ZACTION parameters:

```
--counter <val> Increment classifier hit counter <val>

--arp    Not an action,  match only ARP packets.

-i option can be used to specify ingress port or VLAN,

-d specifies target IP address,

-p specifies arp operation as request (1) or response (2).
```

For arp response, the `-o` field can be used to specify the egress port.

ZACTION Examples

Send all tcp packets arriving on `zhp5` out port 2:

```
iptables -a FORWARD -i zhp5 -p tcp -j ZACTION --set-eport 2
```

Send all tcp packets arriving on `zhp5` to the CPU (software).

```
iptables -a FORWARD -i zhp5 -p tcp -j ZACTION --copy-cpu
```

Set the 802.1p priority to 3 on all tcp packets arriving on `zhp5`.

```
iptables -a FORWARD -i zhp5 -p tcp -j ZACTION --set-prio 3
```

Extensions to the default matches

These are described in the Linux packet filtering HOWTO at:

http://netfilter.org/documentation/index.html#documentation-howto

FORWARDING Chain supports all of them.

`tc` and `zqosd`

`tc`, which stands for Traffic Control, is a mechanism for enabling Quality of Service on Linux. `tc` uses three functional objects: queuing *disciplines*, which comprise queuing and scheduling algorithms such as FIFO queues, priority queues, RED queues, and token buckets; *classes*, which are leafs in queuing discipline hierarchies; and *filters*, such as u32 filters and route filters. In addition to these three building blocks, `tc` also includes policers and meters, which may be associated with filters.

The functional elements of `tc` may be combined to produce complex QoS rules. For example, a packet may be matched to a filter, metered, policed as in-profile or out-of-profile, remarked, mapped to a FIFO queue, and transmitted by a priority scheduler. `tc` is very flexible in the data paths that it allows.

The utility `zqosd` is a daemon that monitors Linux QoS policy and shadows the policy rules into a hardware configuration. When `zqosd` is running, `tc` rules are translated into hardware rules.

NOTE: This document does not detail all of the capabilities of the `tc` command, rather it explicitly mentions only features that are supported by OpenArchitect-based switches.

The examples that follow assume that the switch is running the standard Layer 2 start-up script,

`/etc/rcZ.d/examples/S50layer2`, with all ports placed in a single VLAN, `zhp0`. Note that this assumption is implied only by the fact that changes to `zhp0` are shown to configure all ports. Neither `tc` nor `zqosd` is limited by the interface setup. Each utility works on either VLANs (`zhp`) or ports (`zre`).

FIFO Queues (pfifo and bfifo disciplines)

The simplest configuration for `tc` involves no classes or filters, and only a single FIFO queue. With `tc`, queue sizes may be specified in bytes or packets. The first example defines a packet-limited FIFO. This example begins with only `tc` and then illustrates `tc` in conjunction with `zqosd`.

As a first step, confirm that no `tc` configuration is active on the switch, by listing any queue disciplines:

```
tc qdisc ls
```

The command should return nothing. Now, add a single packet-limited FIFO queue to `zhp0` and confirm that it has been installed to software:

```
tc qdisc add dev zhp0 handle 100:0 root pfifo limit 32
tc qdisc ls
```

The output should display the following,

```
qdisc pfifo 100: dev zhp0 limit 32p
```

The `tc` command is applied to a device, so `dev zhp0` must be specified. Note that a VLAN, such as `zhp0`, and a port, such as `zre0`, are each treated as devices. Breakdown of the options:

handle 100:0

Defines the handle for the queuing discipline. This handle may be used to reference the pfifo queue. Note that the handle is included with the output of the `qdisc ls` command. (100:0 and 100: are equivalent in `tc`.) The choice of handle is significant for `zqosd`.

root

Tells `tc` that this is the base queuing discipline for the device, not a child of another queuing discipline.

pfifo limit 32

Specifies a packet-limited FIFO queue with an upper bound of 32 packets.

Now, delete the queuing discipline from `zhp0` and confirm that it has been removed:

```
tc qdisc del dev zhp0 root
```

```
tc qdisc ls
```

Thus far, `tc` has been used without `zqosd`. It is not sufficient to install software rules on the OpenArchitect switch though, because the normal case is for packets to be switched in hardware. For that reason, `zqosd` must be used to shadow `tc` configuration into hardware. Like `zfilterd`, `zqosd` works with `ztmd`, which provides the actual hardware interaction.

If `ztmd` is not already running, start it:, then initiate the `zqosd` daemon with no parameters:

```
ztmd
```

```
zqosd
```

Now, repeat the same `tc` command as before, to install a packet-limited FIFO queue:

```
tc qdisc add dev zhp0 handle 100:0 root pfifo limit 32
```

When this command is processed, `zqosd` detects the state change and generates output.

For each port belonging to `zhp0`, the queue size has changed to 32 packets. Under the default switch configuration, all ports other than the CPU port belong to `zhp0`; so all queues other than the CPU queue are affected.

As before, remove the `tc` configuration with the command:

```
tc qdisc del dev zhp0 root
```

Note that `zqosd` detects this state change. In fact, examining the CoS configuration on the switch reveals that the queue sizes have reverted to their default values.

The byte-limited FIFO queue case differs only slightly from the packet-limited FIFO case. The syntax is almost identical. In hardware the limit is based on 128-byte cells. The specified byte limit is divided by 128 to determine the cell limit. Always specify a byte limit of at least 128 bytes to avoid setting the queue length to zero.

For example, to set the byte limit for `zhp0` to 4096,

```
tc qdisc add dev zhp0 handle 100:0 root bfifo limit 4096
```

Tear down any installed rules before proceeding with the next example:

```
tc qdisc del dev zhp0 root
```

PRIO and WRR queues

The FIFO examples used a single queue for each interface. In fact, the Ethernet Switch Blade fabric switch is capable of attaching 1 to 8 queues to each port, with either priority or weighted round robin (WRR) scheduling, and classification based on a priority map.

In `tc`, the `prio` queuing discipline establishes multiple queues and specifies their associated priority map. Although WRR support is not part of the standard `tc` distribution, it has been added to the `prio` discipline.

The final example in this document illustrates WRR. A strict priority scheduler is a simpler case that can be constructed easily from this example.

Examine the existing CoS settings on the switch, noting the number of queues per port, queue sizes, scheduling parameters, and priority map. Each of these values changes with this test.

The full set of commands to install four queues, a priority map, and weights is as follows:

```
tc qdisc add dev zhp0 handle 100:0 root prio bands 4 priomap 1
2 2 2 3 3 3 3 1 1 1 1 1 1 1 1 wrr 1 2 4 6

tc qdisc add dev zhp0 parent 100:1 pfifo limit 120

tc qdisc add dev zhp0 parent 100:2 pfifo limit 100

tc qdisc add dev zhp0 parent 100:3 pfifo limit   80

tc qdisc add dev zhp0 parent 100:4 pfifo limit   60
```

The first command attaches a queuing discipline as the root discipline for `zhp0`, with a handle of "100:0," as in the FIFO cases. The "prio" option identifies the type of queuing discipline.

Priority scheduling implies multiple queues and the "bands 4" parameters specify that there are four queues.

The priority map may be read from left to right as *Priority* n *maps to Queue* q, where *n* is the

index of the list element (numbering from 0) and `q` is the value specified by that element. So, this example would read:

Priority 0 maps to Queue 1

Priority 1 maps to Queue 2

Priority 2 maps to Queue 2

Priority 3 maps to Queue 2

Priority 4 maps to Queue 3

Note that the `tc` priority map applies to a 4-bit field. With the Ethernet Switch Blade, the priority map refers to the 802.1p tag, which is a 3-bit field. When translating this `tc` rule to hardware, only Priorities 0 through 7 are significant; the other eight priorities are ignored.

The parameters wrr 1 2 4 6 specify that WRR scheduling is being used and assigns a relative weight to each queue. The weights are treated as numbers of packets to be sent from each queue. In this example, if the queues have sufficient packets, queue 1 will have twice as many packets sent as queue 0, queue 2 will have four times as many, and queue 3 will have six times as many. wrr parameters are scaled such that the maximum value is no more than 15. values which would be 0 are set to 1:

Queue 0 has a weight of 1000 bytes

Queue 1 has a weight of 2000 bytes

Queue 2 has a weight of 4000 bytes

Queue 3 has a weight of 6000 bytes

The remaining commands each define a packet-limited FIFO queue. As with all previous `tc` examples, these queues are created on device `zhp0`. However, unlike all previous examples, they are not created as root disciplines for the device. Instead, the "parent" option identifies them as child queues of the `prio` discipline.

For example, "parent 100:1" identifies that queue as the first child of the `prio` discipline (Queue 0), because the `prio` discipline's handle is 100:0.

After running each of those commands, again examine the CoS parameters. As with the simple FIFO example, queue sizes change to 32 packets. In addition, though, the number of queues changes to 4 for each port in `zhp0`. Furthermore, the weights have changed for each queue, as have the queue mappings.

To test the strict priority case, simply remove the `wrr 1 2 4 6` options from the first `tc` command. Note that all queue disciplines in this test may be cleared by deleting the root discipline, as before:

```
tc qdisc del dev zhp0 root
```

The U32 Filter

The U32 filter provides the capability to match on fields in the L2, L3 or L4 header of a packet. Each match rule gives the location of the field to be tested, which is always a 32 bit word, a mask selecting the bits to be tested, and a value which is to be matched by the packet field. Many matches can be specified in one `tc` filter command. Only if all matches succeed does the filter match. In that case, the `flowid` field identifies the `classid` of the class this packet belongs in.

The following `tc` commands put all icmp packets in class 100:10, packets from IP address 1.2.3.4 in class 100:20. Packets for IP address 1.2.3.4 in class 100:20, and `arp` reply packets in class 100:30. The last filter illustrates using an offset from the beginning of the protocol header, along with a mask, to locate the field to be matched

```
tc filter add dev zhp0 protocol ip parent 100:0 u32 match ip
protocol 1 0xff flowid 100:10

tc filter add dev zhp0 protocol ip parent 100:0 u32 match ip
src 1.2.3.4/32 flowid 100:20

tc filter add dev zhp0 protocol ip parent 100:0 u32 match ip
dst 1.2.3.4/32 flowid 100:20

tc filter add dev zhp0 protocol arp parent 100:0 u32 match u32
2 0xffff at +4 flowid 100:30
```

Combining Queuing Disciplines

Any of the queue length limiting disciplines can be used with the bandwidth management queue disciplines, by defining them with the handle of one of the classes as their parent. For the `htb` queueing discipline, each class has an explicit handle specified when it is defined. For the `prio` queueing discipline, including `wrr`, each band is a class; their handles are formed from the handle of the `prio qdisc` by appending a minor number of 1 to n for the n bands. For example, the following commands define two strict priority queues for port `zre5`, with the lower priority queue limited to 32 kb and the higher priority queue limited to 32 kb:

```
tc qdisc add dev zre5 root handle 100:0 prio bands 2 priomap 0
0 0 0 1 1 1 1

tc qdisc add dev zre5 parent 100:1 handle 110:0 bfifo limit
32kb

tc qdisc add dev zre5 parent 100:2 handle 120:0 bfifo limit
32kb
```

These translation rules handle conversions of individual rules from `tc` entries into hardware entries. They do not explain the results of creating rules that are individually supported; but which do not make sense in conjunction.

Although the translation rules handle some inconsistency between software and hardware, a user must define a combination of rules that is reasonable in hardware, to ensure predictable results.

Handle Semantics

All examples have illustrated `zqosd` copying `tc` rules into hardware. In fact, the `zqosd` utility also enables the user to add `tc` rules that remain only in software. This selection is based on handles. `zqosd` processes all supported queue disciplines and filters with handles between 100:0 and 200:FFFF.

COPS: Common Open Policy Service

The Common Open Policy Service (COPS) is a protocol for distributing networking policy to devices such as switches and routers. COPS allows a single Policy Decision Point (PDP) to distribute policy to multiple Policy Enforcement Points (PEPs). A PDP acts as a server for PEP clients. Figure 4.3 Provides an illustration of the COPS Network Architecture.

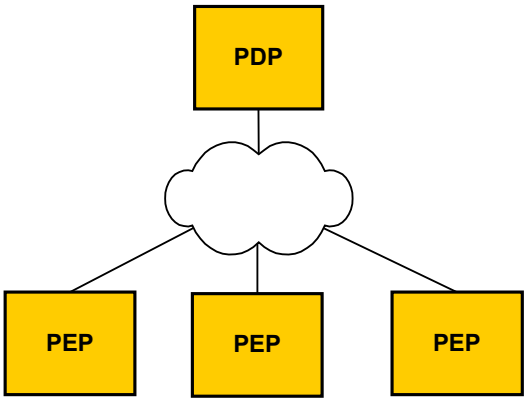


Figure 4.3: COPS Network Architecture

A PDP contains all of the policy rulers for its associated PEPs. A PDP typically stores rules in a data and is a dedicated server, not a forwarding device.

A PEP is any network device that has to enforce policy decisions. For example, a switch that restricts network access or prioritizes traffic fits the definition of a Policy Enforcement Point. A PEP makes no policy decision. It simply applies policy that receives from its PDP.

COPS uses a connection-based query and response mechanism. The following scenario illustrates PEP-PDP communication:

- A PEP comes online and opens a connection to its PDP.
- After a connection has been established, the PEP transmits state information to the PDP.
- The PDP uses that state information to determine what policy is applicable for the PEP.

- The PDP sends that policy to the PEP.
- The PEP installs the policy and applies it to future traffic.

As long as COPS is running, a connection between the PEP and PDP should stay open. A PEP could query a PDP at any time asking for a policy decision. Alternatively, an administrator could modify the policy on a PDP, which would then push any policy changes to its PEPs.

Protocol Architecture

The COPS protocol is broken into several components. The base layer is the COPS protocol itself, which defines the messaging format. This protocol defines *how* communication is handled without specifying the details of the message data.

The base COPS protocol is then used by different *client types*. These client types apply the COPS messaging scheme to particular types of data. The currently standardized client types deal with the RSVP model (COPS-RSVP) and provisioning model (COPS-PR).

The COPS-RSVP scheme is designed around the requirement that a PEP will have to query a PDP in response to events. An RSVP PEP is constantly listening for resource reservation requests and relaying those requests to its PDP.

By contrast, the provisioning model is based on longer lasting policy. The expectation is that policy should be administratively defined at the PDP and pushed to the PEPs as needed. OpenArchitect is a COPS-PR client.

The most common use of COPS-PR is for distributing *Differentiated Services* (Diffserv) policy. Diffserv is concerned with such Quality of Service elements as queues and schedulers.

OpenArchitect PEP

The OpenArchitect PEP implementation is known as `pepd`. The `pepd` utility is based on:

RFC 2478: Common Open Policy Service (COPS)

RFC 3084: COPS Usage for Policy Provisioning

RFC 3159: Structure of Policy Provisioning Information

RFC 3289: Management Information Base (MIB) for the Differentiated Services Architecture

Internet Draft: Differentiated Services Quality of Service Policy Information Base (latest version draft-ietf-diffserv-pib-09)

Internet Draft: Framework Policy Information Base (latest version draft-ietf-rap-frameworkpib-09)

A Policy Information Base (PIB) defines the representation of a particular data set. For example, the Diffserv PIB specifies the structures used to represent all Diffserv elements. PIBs are functionally equivalent to Management Information Bases (MIBs) such as those used by SNMP. The OA PEP has implemented those portions of the Diffserv and Framework PIBs that are supported by the underlying switch architecture.

The `pepd` utility requires a PDP that has implemented the above RFCs and drafts. Until all draft standards are approved, the certain COPS-PR data types will not be assigned OIDs. `pepd` uses non-standard OIDs for the unassigned values.

Using *pepd*

The `pepd` utility works by connection to a PDP, informing the PDP of its *roles*, and installing any rules that the PDP has for those roles. Configuration information should be specified in a configuration file, specified on the command line with the –f option.

```
pepd –f <full_path_and_filename>
```

A sample configuration file is listed below:

```
PDP address: 10.0.0.11
PDP port: 3288
PEPID: some-id
Role-If: a zre1,zre2,zre3,zre4
```

where,

`PDP address`: The IP address of the PDP. Default is loopback (127.0.0.1)

`PDP port`: The destination port on which to open a COPS connection. Default is 3288.

`PEPID`: The PEP Identifier

`Role-If`: A mapping of roles to interfaces. The name of the role is followed by a comma-delineated list of interfaces. Multiple role-interface mappings are defined through multiple Role-If declarations.

Chapter 5 Fabric Switch Administration

One of the main benefits of the OpenArchitect switch is that it runs Linux, so much of the switch administration is already familiar to most network or system administrators. It is a good idea to complement these instructions with a standard Linux reference guide, such as *Linux Network Administrator's Guide* available from O'Reilly. Below are brief descriptions of some of the more routine administrative task pertinent to the switch.

Setting the Root Password

The switch is shipped with a default user root and no password. To set the root password, use the password command:

```
ZX7100-OA<release no.># passwd

Changing password for root

Enter the new password (minimum of 5, maximum of 8 characters)

Please use a combination of upper and lower case letters and
numbers.

Enter new password:

Re-enter new password:

Password changed.

ZX7100-OA<release no.>#
```

NOTE: Even when just changing the password, you need to save the file system overlay with the `zsync` command, or you will lose your changes upon reboot.

Adding Additional Users

Additional users can be added with the `adduser` command. Additional users are desirable for connecting to the switch via `ftpd` and other daemons that require a login other than root and a password. To create a user named guest, run `adduser`

```
ZX7100-OA<release no.># adduser guest

Changing password for guest

Enter the new password (minimum of 5, maximum of 8 characters)

Please use a combination of upper and lower case letters and
numbers.
```

```
Enter new password:
Re-enter new password:
Password changed.
ZX7100-OA<release no.># zsync
ZX7100-OA<release no.>#
```

Setting up a Default Route

If you wish to access the switch from some place other than a directly attached network, you may want to setup a default route. Use the route command to set a default gateway.

```
route add default gw 10.0.0.254
```

Put the entry into the `/etc/init.d/rcS` startup script to automatically set a default route upon reboot.

Name Service Resolution

Name service lookups will be done locally using `/etc/hosts`. You can also tell the switch which name server to use by including an entry in `/etc/resolv.conf`.

DHCP Client Configuration

A utility is included to dynamically determine the IP address of the OpenArchitect switch interfaces. To set the the IP address dynamically, execute the command,

```
dhclient zhp0
```

The default device name, `zhp0`, works with the default configuration of the OpenArchitect switch and will attempt to obtain an IP address from the local DHCP server. To use DHCP to set your IP addresses automatically on boot up, uncomment the the following line in `/etc/init.d/rcS by removing the # sign`

```
/usr/sbin/dhclient zhp0
```

DHCP Server Configuration

The OpenArchitect switch includes a DHCP server. To start the DHCP server, configure `/etc/dhcpd.conf` for your network, and run

```
dhcpd
```

Consult Linux Network administration manuals for more information on DHCP and configuration options.

To use DHCP to set your IP addresses automatically on boot up, uncomment the the following line in `/etc/init.d/rcS by removing the # sign`

```
dhcpd
```

Network Time Protocol (NTP) Client Configuration

NTP is a protocol for setting the real time clock on a system. There are numerous primary and secondary servers available on the network. For more NTP information, and a list of available NTP servers, see the following URL:

http://www.ntp.org/

You will need to have your network settings properly configured to reach an available NTP server on your local network or the internet. To set the time and date, execute `ntpdate` with the server of your choice. For example,

```
ntpdate –u ntp.ucsd.edu
```

The `–u` is required if the OpenArchitect switch is operating behind some types of firewalls.

If you wish for `ntpdate` to set your date and time automatically each time you boot,

uncomment the example `ntpdate` command line in `/etc/init.d/rcS` by removing the **#** sign. `ntpdate` returns the Universal Time (UTC, formerly Greenwich Mean Time, or GMT). To display the localtime, set the `TZ` variable to the appropriate name and the number of hours offset from UTC. For instance,

```
export TZ=PST8
```

for Pacific Standard Time offset from UTC by 8 hours. To set an environment variable, add the entry to `/etc/profile`. Remember to `zsync` to make your changes permanent.

Network File System (NFS) Client Configuration

The OpenArchitect switch includes an NFS client for mounting remote file systems. You will need to start NFS server processes in order to use NFS. You will need to start the following servers:

```
/sbin/portmap
```

```
/sbin/rpc.statd
/usr/sbin/rpc.mountd -r
```

Once the above servers are started, you can mount a remote NFS file system.

```
mount rhost:nfs_file_system local_mount_point
```

If the remote NFS file system you're mounting is on an OA switch, you should mount with caching disabled.

```
mount rhost:nfs_file_system –o noac local_mount_point
```

All the necessary servers are included in `/etc/init.d/rcS` but are commented out by default. To automatically start all NFS client services each time you boot, uncomment the NFS Client servers. Go to the `/etc/init.d/rcS` file. Uncomment the following command lines by removing the **#** sign.

```
/sbin/portmap
/sbin/rpc.statd
/usr/sbin/rpc.mountd -r
```

You can also include commands to mount remote NFS file systems at boot time. There is an example line included at the appropriate location in `/etc/init.d/rcS`. Uncomment and alter the mount command included for your particular configuration.

NOTE: A "sleep" of 5 seconds is included to allow time for the links to come up prior to attempting the mount.

```
sleep 5
mount 10.0.0.1:/nfs –t nfs –o noac /mnt
```

NFS Server Configuration

The switch also contains an NFS server so that you can mount the switch file system from other systems. To enable the NFS server, first follow the steps to enable the NFS client. Then, edit /etc/exports to include the file systems you wish to export. Consult a standard Linux Network Administrator's Guide (or man pages) regarding options for exported file systems. Generally, an entry in /etc/exports looks like the following:

```
/nfs       *.localdomain.com(ro)
```

Now start nfsd to export the mount points and begin answering requests from remote clients.

```
/sbin/rpc.nfsd –r
```

To export file systems automatically on boot, edit /etc/init.d/rcS, uncomment the /sbin/rpc.nfsd command line by removing the #.

```
/sbin/rpc.nfsd -r
```

Connecting to the Switch Using FTP

Use ftp to transfer files to or from the switch. See the *Linux Reference Guide* for details of the ftp command. In general, you can use ftp to connect to any system running an ftp server, including other OpenArchitect switches, to either get (transfer files from the remote host to the switch) or put (transfer files from the switch to the remote host) files.

```
ftp <remote_host>
```

ftpd Server Configuration

The switch itself can also be configured to run an FTP server (ftpd). See the Linux Reference Guide for details of the ftpd command. You will need to add a user to the switch in order to connect via ftp from a remote host, since root is not allowed ftp access. See the earlier section in this chapter regarding how to add a user. The ftp daemon is started by default. If you wish to shutdown the ftp daemon, comment out the betaftpd line in /etc/init.d/rcS.

Connecting to the Switch Using TFTP

Trivial File Transfer Protocol or tftp, is a very simple protocol used to transfer files. It is designed to be small and easy to implement. Therefore, it lacks most of the features of a regular FTP, like user authentication. You can use ftpd to connect to any system running a tftp server (tftpd) including other OpenArchitect switches.

```
tftp <remote_host>
```

TFTPD Server Configuration

The tftp server is started by inetd(8) using the configuration set up in /etc/inetd.conf. The use of tftp(1) does not require an account or password on the remote system. Due to the lack of authentication information, tftpd will allow only publicly readable files to be accessed. The default location of these files is /tftpboot.

SNMP Agent

Simple Network Management Protocol (SNMP) is the defacto standard for network management. An SNMP agent maintains a structure of data for a network device in a virtual information database, called a Management Information Base (MIB). A network management station is capable of accessing the MIB of the network device to monitor and configure the network device.

The OpenArchitect switch utilizes the NET-SNMP (formerly UCD-SNMP) agent core. Additional information on the agent can be found at: http://www.net-snmp.com. The OpenArchitect switch agent will respond to SNMPv1, SNMPv2, and SNMPv3 requests.

Protocols supported on the OpenArchitect switch by *gated*, such as RIP and OSPF communicate with SNMP agent via the SNMP Multiplexing (SMUX) protocol.

Supported MIBS

OpenArchitect includes MIB support as documented by each of the RFCs listed. The MIBs themselves are located on the switch in the `/usr/share/snmp/mibs` directory.

Supported MIBs	
RFC 1155:	Structure and Identification of Management Information for TCP/IP-based Internets
RFC 1227:	SNMP MUX Protocol and MIB
RFC 1493:	Definitions of Managed Objects for Bridges (obsoletes RFC 1286)
RFC 1657:	Definitions of Managed Objects for the Fourth Version of the Border Gateway Protocol (BGP-4) using SMI-V2
RFC 1724:	RIP Version 2 MIB Extension (obsoletes RFC 1389)
RFC 1850:	OSPF Version 2 Management Information Base (obsoletes RFC 1253, which obsoletes RFC 1252, which obsoletes RFC 1248)
RFC 2011:	SNMPv2 Management Information Base for the Internet Protocol Using SMIv2
RFC 2012:	SNMPv2 Management Information Base for the Transmission Control Protocol Using SMIv2
RFC 2012:	SNMPv2 Management Information Base for the User Datagram Protocol Using SMIv2
RFC 2013:	Management Information Base for Network Management of TCP/IP-based internets: MIB-II (obsoletes RFC 1213, which obsoletes RFC 1158)
RFC 2021:	Remote Network Monitoring Management Information Base Version 2
RFC 2096:	IP Forwarding Table MIB
RFC 2571:	An Architecture for Describing SNMP Management Frameworks
RFC 2572:	Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)

Supported MIBs	
RFC 2573:	SNMP Applications
RFC 2574:	User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)
RFC 2575:	View-based Security Model (VACM) for version 3 of the Simple Network Management Protocol (SNMP)
RFC 2576:	Coexistence between Version 1, Version 2 and Version 3 of the Internet-standard Network Management Framework
RFC 2665:	Definitions of Managed Objects for Ethernet-like Interfaces
RFC 2674:	Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions
RFC 2742:	Definitions of Managed Objects for Extensible SNMP Agents
RFC 2787:	Definitions of Managed Objects for the Virtual Router Redundancy Protocol
RFC 2819:	Remote Network Monitoring Management Information Base
RFC 2863:	The Interfaces Group MIB (obsoletes RFC 2233, which obsoletes RFC 1573, which obsoletes RFC1229)
RFC 2932:	IPv4 Multicast Routing MIB
RFC 3165:	Definitions of Managed Objects for the Delegation of Management Scripts
RFC 3231:	Definitions of Managed Objects for Scheduling Management Operations
ZNYX Networks Private MIB	Custom ZNYX MIB to support software and hardware features not covered by standard MIBs. The Private MIBs are ZX7100BASE.MIB AND ZX7100FABRIC.MIB, pointed to by ZNYX-H.MIB.
UCD-SNMP Enterprise MIB	UCD-SNMP MIB related to management and monitoring of the LINUX host

Table 5.1: Supported MIBs

Supported Traps

Upon certain events, the OpenArchitect switch can be configured to send notification of the event, called an SNMP Trap out to a defined recipient/manager or managers. Traps are not issued in real time. OpenArchitect will send SNMP traps for the following conditions:

Supported Traps	
SNMPv2-MIB:	coldStart
SNMPv2-MIB:	authenticationFailure
IF-MIB:	linkUp
IF-MIB:	linkDown
UCD-SNMP-MIB:	ucdShutdown
RMON-MIB:	risingAlarm
RMON-MIB:	fallingAlarm
VRRP:	vrrpTrapNewMaster
VRRP:	vrrpTrapAuthFailure
EGP (rfc1213):	egpNeighborLoss
BGP4-MIB:	bgpEstablished
BGP4-MIB:	bgpBackwardTransition

Table 5.2: Supported Traps

SNMP and OpenArchitect Interface Definitions

OpenArchitect, defines three types of devices:

```
zre   physical port

zrl   trunk of ports

zhp   interface consisting of ports (zres) and trunks of ports
(zrls)
```

A `zrl` (trunk device) is treated as an aggregate of its constituent `zres` (ports). A `zhp` is an aggregate of its immediately contributing sub-interfaces (`zre's` and `zrl's`). The ports that make up a trunk do not contribute to the `zhp`.

The administrative status of a `zre` and `zhp` are independent of each other. If the administrative status is down, then the operational status will be down independent of the underlying link state. You must `ifconfig` up the `zres` to see the operational link status for a `zre`. When the administrative status is up, the operational status is dependent on the underlying physical state. For example, if `zhp0` contains `zre1` and `zre2` the following would be true for the operational status given the administrative status is up on `zre1`, `zre2`, and `zhp0`:

Link and SNMP Status				
Physical Link Status		**SNMP Operational Status**		
zre1	**zre2**	**zre1**	**zre2**	zhp0
down	down	down	down	down
down	up	down	up	up
up	down	up	down	up
up	up	up	up	up

Table 5.3: Link and SNMP Status

The administrative status is directly controlled by `ifconfig` up/down. The administrative status of the `zhps` and `zres` do not affect each other.

ifStackTable Entries

In the actual `ifStackTable` as shown in the MIB walk the following two OIDs (which denote ifIndexes) show the relationships.

```
ifMIB.ifMIBObjects.ifStackTable.ifStackEntry.ifStackStatus.0.1 =
active(1)

ifMIB.ifMIBObjects.ifStackTable.ifStackEntry.ifStackStatus.0.2 =
active(1)
```

If they are X.Y then

- if X = 0 there is nothing above this interface
- if Y = 0 there is nothing below this interface

otherwise interface X has interface Y as a logical constituent.

SNMP Configuration

The SNMP agent is called snmpd and is started by default from the Linux boot up script `/etc/rcZ.d/S75snmpd`. If you do not wish to start snmpd, remove `etc/rcZ.d/S75snmpd`.

Configuration of the OpenArchitect switch SNMP agent is the same as configuration of any standard Linux host that uses the NET-SNMP agent. Configuration information for persistent data and security information is kept in `snmpd.conf` under the default SNMP configuration location, which for the OpenArchitect switch is `/usr/share/snmp. snmpd.conf` is the location to change `sys` information such as the `syslocation` and `syscontact`, as well as permissions such as the `rocommunity` or `rwcommunity`.

NOTE: For NET-SNMP agents, these objects (`sysLocation.0`, `sysContact.0` and `sysName.0`) ordinarily are read-write. However, specifying the value for one of these objects by giving the appropriate token in `snmpd.conf` makes the corresponding object read-only, and attempts to set the value of the object will result in a notWritable error

response.

The processing for link up and link down traps is now user configurable. As the default, traps conform to RFC2863, meaning the trap contents will include:

```
ifIndex, ifAdminStatus and ifOperstatus
```

You can alter this behavior by specifying:

```
cisco_link_traps on
```

If `cisco_link_traps` are turned on as described then link up and link down traps will have a cisco-like format and the trap contents will include:

```
ifDescr and ifType
```

Examine and edit `/usr/share/snmp/snmpd.conf` appropriately for your configuration. Information in `/usr/share/snmp/snmpd.conf` is only read at startup - or when the daemon is forced to reread its configuration. See the standard Linux man page for `snmpd.conf` for more details.

SNMP Applications

The OpenArchitect switch includes the `snmpget`, `snmpwalk`, and `snmpset` applications you can use these standard Linux utilities to test your SNMP agent. For example,

```
snmpwalk localhost –c public
```

walks the entire MIB of the localhost (that is, OpenArchitect switch) starting at the top of the MIB. See the *Linux Reference Man Pages* for the usage of the SNMP utilities.

MIB values are decoded from their numerical representations into readable text by parsing MIBs located in the `/usr/share/snmp/mibs/` directory. If you need to add a MIB, add it to that directory and `zsync` to save across reboots.

Port Mirroring

`zmirror` sets packet mirroring from a given set of ports to a given port. Turning on packet mirroring causes a copy of the packet to be sent to the `mirror_to` port. There is only one `mirror_to` port, and no limitation on `mirror_from` ports. Use the `zmirror` command in the following way,

```
zmirror mirror_from mirror_to
```

After executing the following three commands, packets received on ports 0, 1 and 2 would be

mirrored (copied and transmitted) to port 12. This mirroring would be in addition to any Layer 3 or Layer 2 switching.

```
zmirror zre0 zre12
zmirror zre1 zre12
zmirror zre2 zre12
```

To clear the current mirroring use the `-t` option. The `-e` option can be used to indicate that packets being sent on a given port should be copied to the `mirror_to` port. For example if the `-e` option is used as follows, the packets transmitted, as opposed to received, on ports 0, 1 or 2 would be mirrored to port 12.

```
zmirror -e zre0 zre12
zmirror -e zre1 zre12
zmirror -e zre2 zre12
```

Link and LED Control

The `zlc` application sets the link speed and state of individual ports of the switch, or display their current state. It can also set or clear the extract led or the internal fault led, or to set a port down or up. To force the link on port 0 down,

```
zlc zre1 down
```

To check the status of a link,

```
zlc zre1 query
```

To check the status of all links,

```
zlc zre0..51 query
```

Link Event Monitoring

The `zlmd` application is intended to run as a daemon, waiting for a configured event to occur and then running the program configured for that event. The events monitored are changes in the link status at any of the in-band ports of the switch, the start of removal of the switch from the ATCA backplane, or the cancellation of the removal before it actually takes place. The program can be a shell script that initiates appropriate actions to respond to the event.

Chapter 6 Fabric Switch Maintenance

This chapter includes basic information about the OpenArchitect switch environment including an overview of the file system structure, modifying and updating switch files, upgrading the switch driver and kernel, and implementing a system recovery.

Overview of the OpenArchitect switch boot process

The OpenArchitect switch is equipped with a Random Access Memory (RAM) disk and three Read-Only Memory (ROM) devices, including, a boot ROM and two application flash devices.

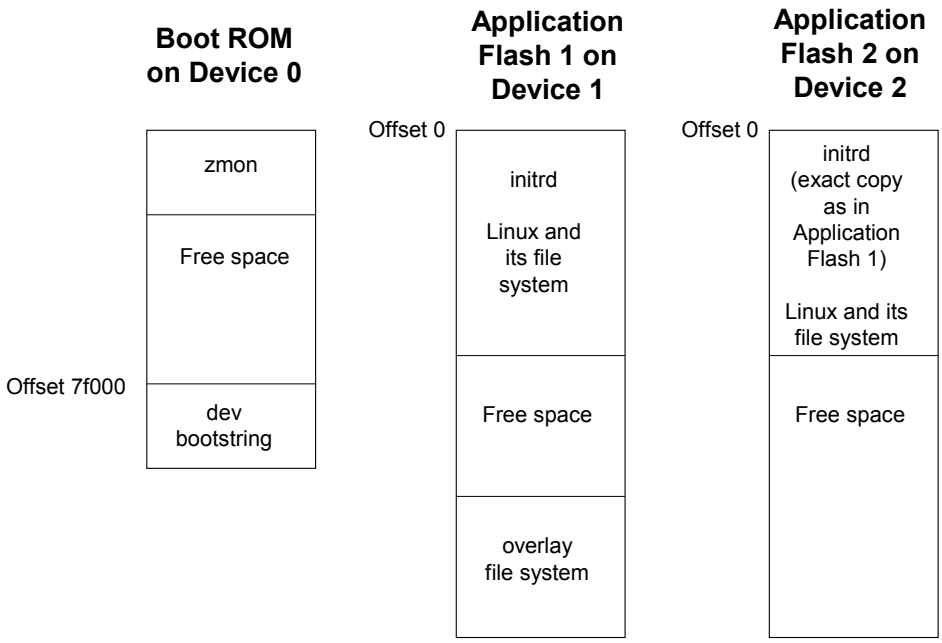


Figure 6.1: ROM Devices in Open Architect

The boot ROM is located on device 0 and contains the OpenArchitect `zmon` application that operates as a boot loader and includes a device bootstring. Device 1 contains the application flash 1 image of the Linux operating system and the OpenArchitect overlay file system. Application flash 1 is the primary working image for the switch. Device 2 contains the application flash 2 that is an exact copy of application flash 1. You would only boot from this device if application flash 1 is corrupted and you need to restore the switch to the factory-shipped configuration.

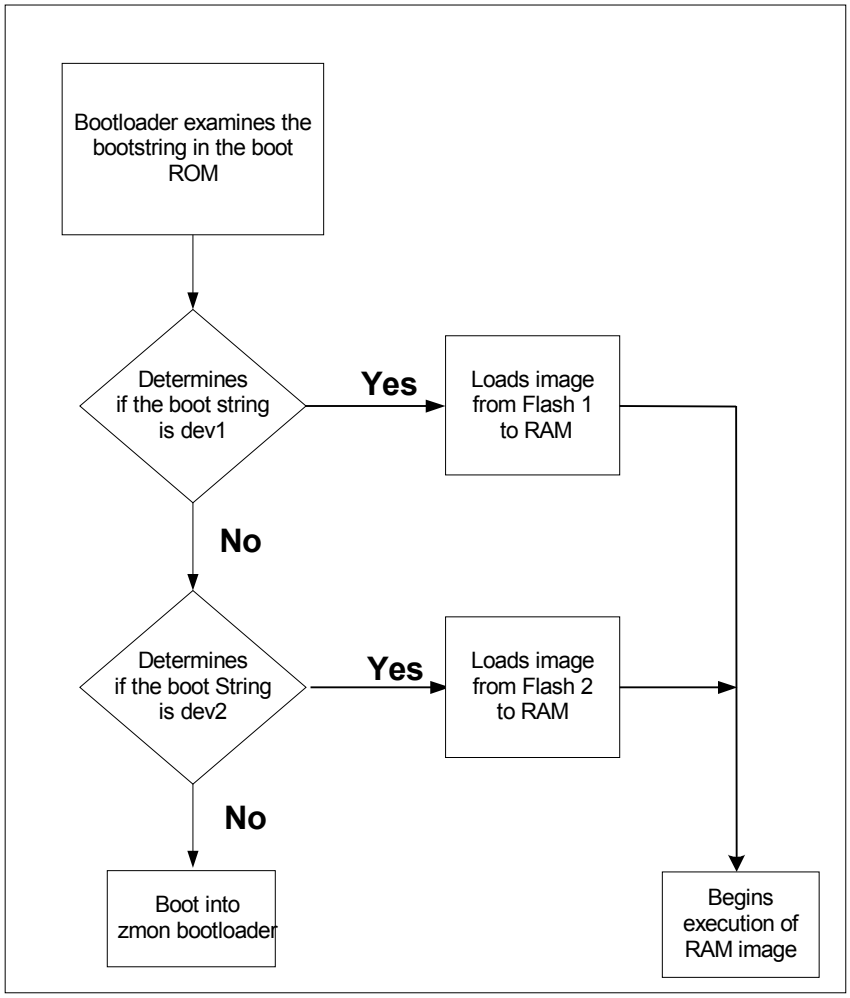


Figure 6.2: Boot Flow Chart

Under normal circumstances, the booting up process follows the process outlined in Figure 6.2. During boot up, the `zmon` bootloader reads the device bootstring to locate and validate the correct application image to load. The bootstring command is in the following format:

`boot : X | [<options>]` X represents the device value 0, 1 or 2

The boot process opens and uncompresses the `initrd` image onto the RAM disk. Then `zmon` begins booting the Linux image. After Linux boots, the `init` process executes the `/etc/init.d/rcS` script which, in turn, executes `/etc/rcZ.d/rc` (see Figure 6.3: Init Script Flow). The `/etc/rcZ.d/rc` script runs `S*` files in `/etc/rcZ.d`, with the start parameter. The `S*` files are the switch configuration files (for example, `S50layer2`).

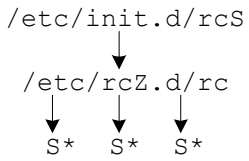


Figure 6.3: Init Script Flow

Saving Changes

Any modifications made to the scripts for your particular configuration must be properly saved or your changes are lost when you reboot. The file system for the switch only exists in memory. A rewritable overlay is contained within the upper four megabytes of the first application flash.

Modifying Files and Updating the Switch

Any file in OpenArchitect can be added, deleted or modified, with the exception of `/sbin/init`, `/usr/sbin/zmnt`, `/lib/modules/zfm_c.o`, and the /tmp directory. Files are saved across a system reboot by running the script `zsync`.

A directory /.`zsync` contains database files used by `zsync` for managing the file system overlaying process. The user should not modify the files in this directory or unpredictable results may occur.

Recovering from a System Failure

If the switch does not function after you initially change or reconfigure the image, you have several options for recovering from an error. First, try to `telnet` into the switch. If you are successful, remember to run `zsync` after fixing your problem.

If you cannot `telnet`, attach a console cable to the switch. Bring down the system and properly attach the console cable, see *Connecting to the Console Port* .

System Boots with a Console Cable

After attaching the system console cable, if the system boots, fix the problem that does not allow you to `telnet` to the box, run `zsync`, and reboot. The problem is likely to be in the

configuration files contained in /etc/rcZ.d In order to telnet into the box, there must be a configured interface with a proper IP address. For example, zhp0 is configured with the IP address 10.0.0.43 in the factory default configuration.

Booting with the –i option

If you cannot telnet into the switch and Linux fails to boot, it is likely that a change saved by zsync has left the switch in an inaccessible state. To allow users to recover from mistakes saved in the overlay file system, a boot argument of –i passed to the init process will stop the untarring of the saved overlay files. As a result, the system boots to the factory-shipped configuration.

- Connect through the console port. During boot up, the system displays the Linux boot string. Linux/PPC load: for 5 seconds. During the 5 second pause, enter the boot option –i and press Return

```
Linux/PPC load: root=/dev/ram init=/sbin/init -i
```

- Initiating the –i option of zbootcfg.

```
zbootcfg –d 1 –i
```

- Reboot the system. After the reboot, clear the –i option from the boot string. Enter the following command:

```
zbootcfg –d 1
```

The reboot command will also take –i as an option and pass it to the Linux boot,

```
reboot -i
```

- When the system boots, the overlay file system is returned to the factory-installed configuration. At this point, you have a few options.
- Run zsync and the factory-installed system will be restored to your flash.

  CAUTION: All changes you have made and saved prior to the zsync command will be lost.

- Restore particular files from the existing overlay. Use the zmnt command to mount the overlay in a designated directory and copy back just the changes you want to keep from the existing overlay. For example, if you wanted to recover your /etc/hosts file from the existing overlay, use zmnt to mount the overlay in a designated directory, like /tmp, then copy /tmp/etc/hosts to /etc/hosts. Lastly, use zsync to save your changes.

```
zmnt /tmp
cp /tmp/etc/hosts /etc/hosts
```

```
zsync /etc/hosts
```

- Reboot the system.

System Hangs During Boot

After attaching the system console cable, if the system hangs during boot, try booting with the *–i* option as described in the previous section. It is possible that important Linux system files became corrupted and incorrectly saved in the flash overlay. Use `zmnt` as described in the previous section to fix or remove the problem files from the overlay. If the system will not boot with the `-i` option, refer to *Booting the Duplicate Flash Image* section in this chapter.

Booting the Duplicate Flash Image

Another recovery method, if Linux fails to boot, is to temporarily boot the factory-installed duplicate image located in the second flash device.

Connect through the console port.

When you see the number counter appear after the `zmonitor` … banner, press any key on the console keyboard to enter the `zmon` application.

At the monitor prompt, type:

```
boot:2
```

You should see the counter again, but the system should boot into the secondary kernel. If you have difficulties booting, contact Hewlett-Packard technical support.

At this point, follow the *Upgrading the OpenArchitect Image* section to put a new RAM disk image in the application flash 1.

> **IMPORTANT: Be sure not to program flash 2, since currently this is your only bootable image.**

The command to program flash 1 should be similar to the following command. The image name may be slightly different depending on the model of switch and version of the image:

```
zflash -d 1 rdr7100.zImage.initrd
```

Upgrading the OpenArchitect Image

Use `telnet`, or preferably, attach a console cable to the switch, and login to the switch. If you are connecting via `telnet`, be aware that the upgrade process will reset the switch to the default IP address of 10.0.0.43, so you will have to be able to reach 10.0.0.43.

Download the OpenArchitect image to a local system.

The OpenArchitect image is very close to the limit of free space available on a default system so you may need to clear some space prior to downloading the OpenArchitect image to the switch. Check for free space with the `df` command.

One of the easiest ways to create free space is to remove `/usr/sbin/gated`. The application will be replaced during the update procedure. Once you have enough free space, proceed.

- From the switch console, `ftp` the new OpenArchitect (rdr) image from the local system to your switch.
- The switch has two flash available: Device 1 and device 2. Use the `zflash` command to write the new OpenArchitect image into the first flash device.

NOTE: Make sure that Surviving Partner is not running before using `zflash`. The delays incurred while `zflash` writes the flash can cause the Surviving Partner daemons to think there is a failure, resulting in link oscillation.

```
zflash -d 1 <image_file>
```

The image file will be something named similar to the following,

```
zflash -d 1 rdr7000.zImage.initrd
```

Upgrading or Adding Files

Follow the procedure below to upgrade or add a new file to the switch. Place the file you are adding or upgrading into the appropriate location in the file system. Save the file in the overlay directory area on the application flash by running `zsync`.

```
zsync
```

After running `zsync`, the file is saved to the flash for future reboots.

Excluding Saving Files to Flash

Specific files or directories can be excluded from saving to flash by `zsync` by including an entry in `/etc/exclude`. Likewise, existing entries in `/etc/exclude` such as /tmp can be removed in order to save those files to flash with zsync.

Upgrading the Switch Driver

The switch driver upgrade process is the same as a file upgrade. However, more caution should be taken since the driver module is likely to be the method by which you are logging into the system. If the switch driver has a problem, you will need to have a console cable to recover. To upgrade a switch driver, replace the file `/lib/modules/if_zxe.o`, run `zsync` and reboot.

Using `apt-get`

`apt-get` is a utility created by the Debian Linux community to allow remote fetching and installation of software stored in a repository in Debian package format. It allows users to keep their software up-to-date with the latest binaries, and install new software without the need to recompile.

Users may create their own repositories and add entries in `/etc/apt/sources.list` (empty by default) for their private access methods to their private repository. See http://www.debian.org for complete APT documentation.

Chapter 7 Base Switch Configuration

At this point, the OpenArchitect Ethernet Switch Blade should be installed and powered up for the first time. This chapter helps you connect and configure the base switch by presenting command line examples as well as a discussion of the example configuration scripts. You may configure the fabric switch independently from the base switch.

Two switches, two consoles

There are two separate switches in the Ethernet Switch Blade. The base switch handles traffic among base ports 0-23. These ports are reserved for control functions on the ATCA rack such as connecting to IPMI (shelf managers), and connecting each node card to control and monitoring devices.

Connecting to the Base Switch Console

You can connect to the switch console using a `telnet` connection or with a console cable. Use the procedure below for a `telnet` connection. See *Connecting to the Console Port*, for instructions.

- Connect an Ethernet cable to the host and the switch.
- Configure a host on the 10.0.0.0 network.
- The OpenArchitect switch is pre-configured with address 10.0.0.42. `telnet` to 10.0.0.42.

```
telnet 10.0.0.42
```

After you are connected, enter the login name root. No password is required.

```
ZX6000-OA login: root
ZX6000-OA<release no.>#
```

OpenArchitect Configuration Procedure

Switch configurations can be accomplished with a few simple commands. Once you've configured your switch, the commands should be placed into a start up configuration script. Like most Linux systems, the OpenArchitect switch boot process runs initialization commands and scripts in `/etc/init.d/`. In particular, OpenArchitect runs `/etc/init.d/rcS` which in turn executes all scripts located in `/etc/rcZ.d` starting with an uppercase "`S`" in alphabetical order. Any configuration scripts you create should be named in the standard Linux/Unix manner, starting with an uppercase "`S`" and numbered in the sequence you would like them executed. The final step once the switch has been properly configured is to use the `zsync` command to save all

files into flash for reloading.

Changing the Shell Prompt

You may use standard bash shell procedures to change the prompts on your base switches. Many sites choose a system that distinguishes among the individual switches at their location. The same rules apply for saving your choice (`zsync`) as for all other configuration changes.

Default Configuration Scripts

As shipped the following scripts are run from `/etc/rcZ.d` as the switch boots up:

- `S20stack` - Script that calls `zstack` to combine the two BCM5695 twelve-port switch fabric chips into a single 24 port virtual switch. `zstack` must be run before any other switch configuration.
- `S30e1000` - Script that loads the e1000 driver module for the Out-of-Band Ethernet ports.
- `S40vpd` - Script that checks the current OA version, and loads into the Vital Product Data (VPD) area if necessary.
- `S50layer2` - Script that sets up a basic Layer 2 switch. All 24 10/100/1000 ports are set up on one IP network (VLAN). The ISL is set up in its own vlan.

Example Configuration Scripts

Example scripts are supplied that can be used as templates. Use one of the scripts located in the switch `/etc/rcZ.d/examples` directory to help you configure the switch. The default configuration for the switch is located in the script file `/etc/rcZ.d/S50layer2`.

The following scripts are included. Each is examined in more detail later in the appropriate section describing common Layer 2 and Layer 3 configurations:

- `S50layer2` - Script which sets up a basic Layer 2 switch. All 24 10/100/1000 ports are set up on one IP network (VLAN). This is a copy of the switch in `/etc/rcZ.d` that is loaded in the default configuration.
- `S50layer2sp` - Script which sets up a basic Layer 2 switch. All 24 10/100/1000 ports are set up on one IP network (VLAN), and turns on bridge support for Spanning Tree.
- `S50layer3` - Script which sets up a basic Layer 3 switch. All 24 10/100/1000 are set up on individual IP networks (VLANs). Layer 3 switching is enabled.

- `S50multivlan` - Script which sets up multiple untagged VLANs. The first VLAN includes the first ten 10/100/1000 ports, the next contains the last ten 10/100/1000 ports, the third VLAN contains two 10/100/1000 ports, the last VLAN contains the last two 10/100/1000 ports. Layer 3 switching is enabled.

- `S55gatedRip1` - Script which is used with a Layer 3 switch and calls the GateD daemon to enable RIP 1 routing protocol.

- `S55gatedRip2` - Script which is used with a Layer 3 switch and calls the GateD daemon to enable RIP 2 routing protocol.

- `S55gatedOspf` - Script which is used with a Layer 3 switch and calls the GateD daemon to enable OSPF routing protocol.

Overview of OpenArchitect VLAN Interfaces

When you initially boot up the switch, one virtual host port is automatically created by OpenArchitect to enable interaction between the software and hardware. This initial host port, called ZNYX Host Port (`zhp`), is a network interface that provides communication between all 24 in-band ports. Therefore, linking to any port on the switch enables you to connect with OpenArchitect.

A `zhp` device is associated with one Virtual Local Area Network (VLAN). A virtual local area network (VLAN) is a logical mapping of workstations and network devices on some basis other than geographic location (for example, by department, type of user, or primary application). The primary purpose of a VLAN is to isolate traffic and enable communication to flow more efficiently within groups of mutual interest. VLANs reduce the time it takes to implement workstation and network moves, adds and changes. The switch is used to bridge from one VLAN to another. Figure 7.1 is an illustration of multiple VLANs.

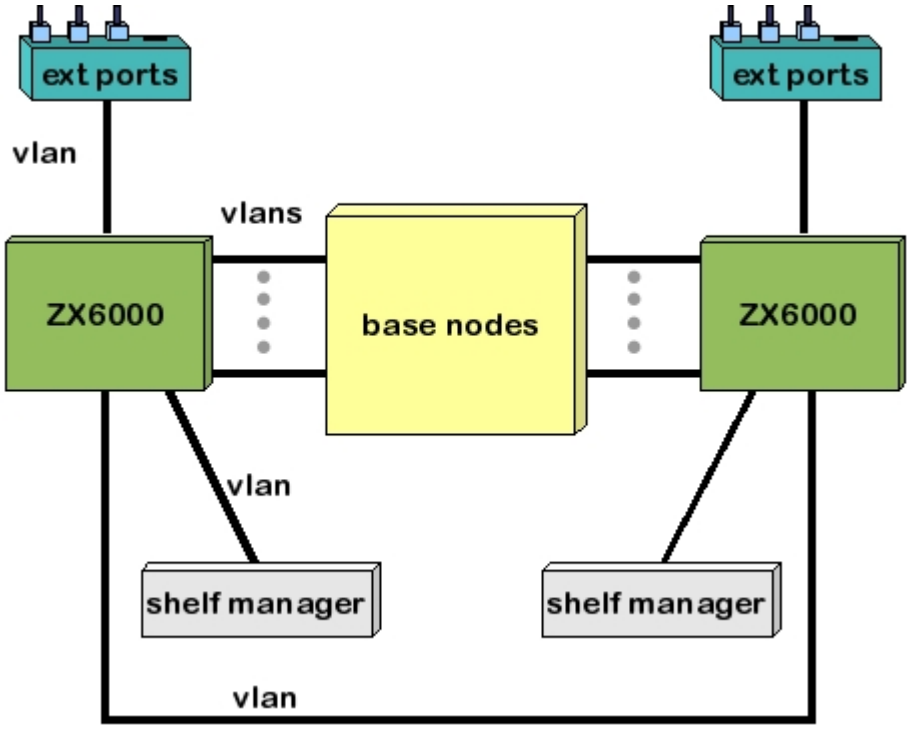


Figure 7.1: Multiple VLANs

Tagging and Untagging VLANs

The OpenArchitect switch is capable of switching VLAN tagged and untagged data packets. VLAN tagged packets conform to the 802.1q specification and the packet header contains an additional four bytes of VLAN tag information. A given port can be specified to accept VLAN tagged or untagged traffic. Internally, all traffic for a particular VLAN is treated as tagged traffic.

Switch Port Interfaces

For each switch port, OpenArchitect creates a separate interface with its own MAC address called a ZNYX raw Ethernet (`zre`). After the initial power up, 24 `zre` interfaces are created, one for each in band port. You cannot directly access or modify the `zre` interfaces.

During the initial power up of the switch, the default configuration creates a Layer 2 switch. The Layer 2 configuration places all of the `zre` interfaces in the same `zhp` interface. The number after `zre` represents the corresponding switch port number (that is, `zre1` represents port 1 on the switch).

Layer 2 Switch Configuration

The steps to build a Layer 2 switch involve creating a group of switch ports in a VLAN (or Layer 2 switching domain) and bringing that interface up. `zconfig` creates the VLAN group of switch ports as well as a network interface. Use `ifconfig(1M)` on the network interface to bring up the VLAN group. Figure 7.2 provides an illustration of a Layer 2 Switch connection.

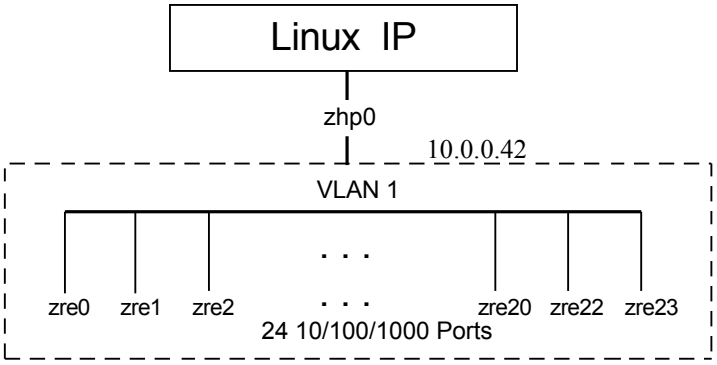


Figure 7.2: Layer 2 Switch

During the initial power up, a startup script called `/etc/rcZ.d/S50layer2` is executed at boot time creating a single untagged VLAN (IP interface labeled as `zhp0`) which includes all Ethernet and gigabit ports as one Layer2 switch. The interface to the host is then assigned the IP address of 10.0.0.42 to allow access to the switch. The `S50layer2` script does the following:

- Uses `zconfig` to create and configure a single, untagged VLAN that contains all 24 switch ports.

```
/usr/sbin/zconfig zhp0: vlan1=zre0..23

/usr/sbin/zconfig zre0..23=untag1
```

- Uses `ifconfig(1M)` to assign the IP address 10.0.0.42 to the interface.

```
/usr/sbin/ifconfig zhp0 10.0.0.42 up
```

To create another VLAN that only contained the two ports, first use `zconfig` from the command to build the VLAN and create a network interface for the host.

```
zconfig zhp1: vlan2=zre20,zre21
```

Then, bring up the interface with `ifconfig(1M)`:

```
ifconfig zhp1 193.08.1.1 up
```

Note that ports `zre20` and `zre21` are members of both vlan1 and vlan2, and that they are tagged for vlan2. A port cannot be untagged for more than one VLAN. You can view the configured VLANs with `zconfig`.

```
zconfig -a
```

Using the S50layer2 Script

The S50layer2 script can be used and example, or edited to customize your Layer2 setup. For example, to reconfigure the IP address on your Layer 2 switch**,**

- Open the S50Layer2 file in the Linux *vi* editor.
- Change the IP address value listed under the Linux `ifconfig(1M)` command line.
- Save your changes by running OpenArchitect `zsync`.
- Reboot the switch.

Rapid Spanning Tree

The Rapid Spanning Tree Protocol (RSTP) configures a simply connected active topology from the arbitrarily connected components of a Bridged Local Area Network. RSTP participants use a simple dialog carried in packets called Bridge Protocol Data Units (BPDUs) for finding the shortest path between two networks and for eliminating loops from the topology. If nodes attached to ports fail or are added or deleted, the topology dynamically changes to accommodate the new configuration. If your network topology is such that there is no real redundancy or chance for loops, you do not need to turn on Spanning Tree.

`zl2d` is a shell script used to create Linux bridges consisting of the name of the previously created `zhp` device or devices preceded with a "`b`" (for example, if you are creating a Bridge device from `zhp0`, the resulting device would be b`zhp0`). `zl2d` then starts a background task that monitors the port information of the Linux bridge at a specified interval and updates the Spanning Tree state fields in the hardware when necessary.

`brctl(8)` is called by `zl2d` for configuring certain RSTP parameters. For an explanation of these parameters, see the IEEE 802.1d specification, or reference the `brctl(8)` man page in Appendix A. The following demonstrates a simple example of setting up a Layer 2 switch and starting RSTP.

To Enable Rapid Spanning Tree:

Create a VLAN containing the ports that will be a part of the Linux bridge running Rapid Spanning Tree. This example will use ports 0-3 (untagged):

```
zconfig zhp0: vlan1=zre0..3
zconfig zre0..3=untag1
```

Create a bridge device from the `zhp` device,

```
zl2d start zhp0
```

A Bridge device named b`zhp0` should now exist consisting of ports `zre0` through `zre3` with Spanning Tree enabled. To view the bridge device, use the `brctl` command,

```
brctl show
brctl showbr bzhp0
```

Port Path Cost

Each port has an associated cost that contributes to the total cost of the path to the Root Bridge when the port is the root port. The smaller the cost, the better the path. The Ethernet Switch Blade uses the following IEEE 802.1D recommendations based on the connection speed of your port:

Port Path Cost		
Link Speed	**Recommended Value**	**Recommended Range**
10 Mb/s	100	50-600
100 Mb/s	19	10-60
1 Gb/s	4	3-10

Table 7.1: Port Path Cost

To change the port path, use the `brctl setpathcost` option. For example, to set the port priority to a value consistent with a gigabit interface,

```
brctl setpathcost bzhp0 zre1 4
```

Layer 3 Switch Configuration

The previous section outlines the Layer 2 switch configuration that is automatically configured when you initially bring up the OpenArchitect switch. In order to communicate between Layer2 interfaces, you must properly setup routing.

The steps to build a Layer 2 switch involve creating a group of switch ports in a VLAN (or Layer 2 switching domain) and bringing that interface up. `zconfig` creates the VLAN group of switch ports as well as a network interface. Use `ifconfig(1M)` on the network interface to bring up the VLAN group with Layer 2 switching. Layer3 routing information is then used to route between the Layer2 network devices.

Take a simple example of two VLANs configured on the switch, each with four ports. First teardown any existing configuration,

```
zconfig –t
```

Use `zconfig` to create two new VLANs, each with four ports, and untag them,

```
zconfig zhp0: vlan1=zre1..4

zconfig zre1..4=untag1
```

```
zconfig zhp1: vlan2=zre5..8

zconfig zre5..8=untag2
```

Now, use `ifconfig` to assign each `zhp` interface an IP address,

```
ifconfig zhp0 10.0.0.1

ifconfig zhp1 11.0.0.1
```

At this point, the Linux host has enough information to route between the networks of the directly attached interfaces, 10.0.0.0 via `zhp0`, and 11.0.0.0 via `zhp1`.

The next step is to enable the ZNYX `zl3d` daemon to move that routing information from the host to the base switch switching tables in silicon. Once enabled, `zl3d` will monitor the Linux routing tables for changes in configuration and update the switch silicon tables. Start `zl3d` to update the switch tables:

```
zl3d zhp0 zhp1
```

The base switch switch is now configured as a Layer3 switch that can route between two Layer2 devices in silicon.

Using the S50layer3 Script

To modify the configuration to a Layer 3 switch, remove the `S50layer2` file from the `/etc/rcZ.d` directory, and replace it with the example script file, `S50layer3`.

In the `S50layer3` file, each port is assigned its own Virtual Local Area Network (VLAN) interface (port interfaces are labeled as `zhpN`, where `N` is an integer). Each VLAN is associated with an individual `zhp` interface. Remember, `zre` and `zhp` interfaces can begin with a zero value but a VLAN cannot. Each `zre` interface is assigned a separate IP address in the example script (see Figure 7.3).

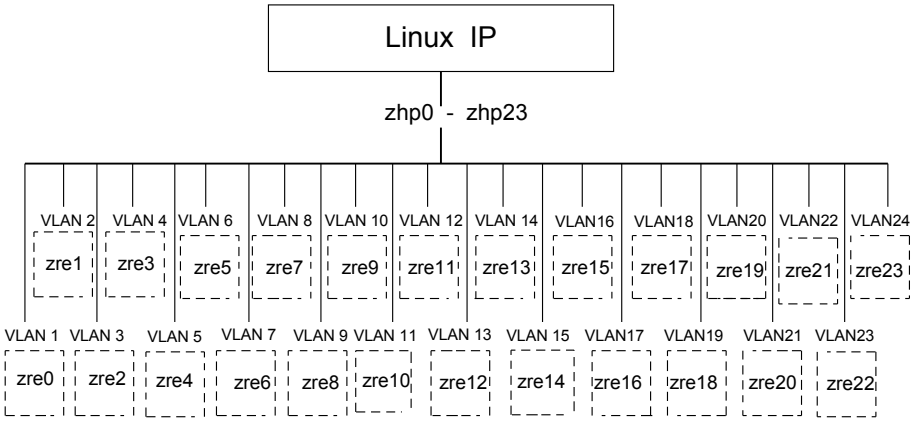


Figure 7.3: Layer 3 Switch

The `S50layer3` script executes the following commands:

- Runs `zconfig` command to create 24 untagged VLANs (one for each switch port).

```
/usr/sbin/zconfig zhp0..23: vlan1..24=zre0+
/usr/sbin/zconfig zre0..23=untag1+
```

NOTE: Double periods (..) after vlan1 and untag1 are used to indicate a range of values. The plus (+) sign after zre1 is a wildcard character that means auto-incremented and causes each `zhp` interface to hold only one `zre` (that is, `zhp0` has `zre1` on `vlan1`, `zhp1` has `zre1` on `vlan2`).

- Runs the Linux `ifconfig(1M)` command for each interface to assign default IP addresses (10.0.0.42-10.0.23.42), sets the netmask and brings up the interfaces.

```
ifconfig zhp0 10.0.00.42 netmask 255.255.255.0 up
ifconfig zhp1 10.0.01.42 netmask 255.255.255.0 up
ifconfig zhp2 10.0.02.42 netmask 255.255.255.0 up
.
.
.
ifconfig zhp21 10.0.21.42 netmask 255.255.255.0 up
ifconfig zhp22 10.0.22.42 netmask 255.255.255.0 up
ifconfig zhp23 10.0.23.42 netmask 255.255.255.0 up
```

- Runs the OpenArchitect `zl3d`. The `zl3d` application monitors the Linux routing tables and updates the switch routing tables for each interface configured above.

```
/usr/sbin/zl3d zhp0..23
```

`zl3d` initially creates and adds each `zhp` interface (VLAN) to the switch routing tables. The `zhp0..zhp23` is shorthand for the list of interfaces (`zhp0`, `zhp1`, …, zhp23) to monitor with `zl3d`.

To Modify the Layer 3 Script

- Modify the example script you copied into the `/etc/rcZ.d` directory. Adjust and assign the number of IP addresses as applicable. In the example below, the IP address is changed for the interface in the `ifconfig` command line of the script.

From:

```
ifconfig zhp0 10.0.0.42 netmask 255.255.255.0 broadcast 10.0.0.255 up
```

To:

```
ifconfig zhp0 193.08.1.1 netmask 255.255.255.0 broadcast
193.08.1.255 up
```

- Adjust the number of `zhp` interfaces, that are added to the routing tables, depending on the number of VLANs you are adding for your network. Include any other details, as applicable.
- Run the OpenArchitect `zsync` command to save your changes.

```
zsync
```

- Reboot the switch.
- After rebooting, your switch works from your customized Layer 3 configuration.

Layer 3 Switch Using Multiple VLANs

An example script is also provided for setting up multiple VLANs each with multiple ports.

Using the S50multivlan Script

The Layer 3 switch example file, S50multivlan, is included to help you configure multiple VLANs to a Layer 3 switch. A VLAN can include one or more switch ports. In the S50multivlan file, four VLANs are created (see 4):

- VLAN 1, `zhp0`: for the first set of six ports, zre0-zre5
- VLAN 2, `zhp1`: for the second set of six ports, zre6-zre11
- VLAN 3, `zhp2`: for the third set of six ports, zre12-zre17

- VLAN 4, zhp3: for last set of six ports, zre18-zre23

Each VLAN interface is labeled zhpN in the file, where N is a value from 0-3. Each interface is untagged and assigned its own IP address (see Figure 7.4).

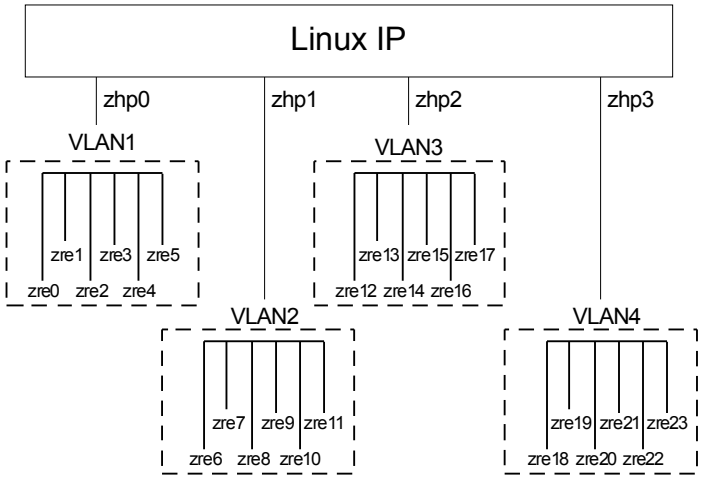


Figure 7.4: Multiple VLAN Configuration

The S50multivlan script executes the following commands:

- Runs zconfig to create and start four VLANs. Switch ports 0-9 are placed in the first VLAN, ports 10-19 in the second VLAN, ports 20-21 are placed in the third VLAN, and ports 22-23 are placed in the fourth VLAN.

```
/usr/sbin/zconfig zhp0: vlan1=zre0..5
/usr/sbin/zconfig zre0..5=untag1
/usr/sbin/zconfig zhp1: vlan2=zre6..11
/usr/sbin/zconfig zre6..11=untag2
/usr/sbin/zconfig zhp2: vlan3=zre12..17
/usr/sbin/zconfig zre12..17=untag3
/usr/sbin/zconfig zhp3: vlan4=zre18..23
/usr/sbin/zconfig zre18..23=untag4
```

NOTE: Double periods (..) after vlan1 and untag1 are used to indicate a range of values.

- Runs the Linux ifconfig command for each interface to assign default IP addresses

(10.0.0.42-10.0.3.42), assigns the netmask and brings them up.

```
ifconfig zhp0 10.0.0.42 netmask 255.255.255.0 broadcast 10.0.0.255 up

ifconfig zhp1 10.0.1.42 netmask 255.255.255.0 broadcast 10.0.1.255 up

ifconfig zhp2 10.0.2.42 netmask 255.255.255.0 broadcast 10.0.2.255 up

ifconfig zhp3 10.0.3.42 netmask 255.255.255.0 broadcast 10.0.3.255 up
```

- Runs the OpenArchitect `zl3d` command. The `zl3d` application monitors the Linux routing tables and updates the switch routing tables for each interface configured above.

```
/usr/sbin/zl3d zhp0..3

zhp0 zhp1 zhp2 zhp3
```

The `zl3d` application initially creates and adds each `zhp` interface (VLAN) to the switch routing tables.

To Modify the Layer 3 Multivlan Script

Modify the example script you copied into the `/etc/rcZ.d` directory. Adjust and assign the number of IP addresses as applicable. In the example below, the IP address is changed for the interface in the ifconfig command line of the script.

```
ifconfig zhp0 10.0.0.42 netmask 255.255.255.0 up

ifconfig zhp0 193.08.1.1 netmask 255.255.255.0 up
```

- Adjust the number of `zhp` interfaces depending on the number of VLANs you are adding for your network.
- Include any other details, as applicable.
- Run the OpenArchitect `zsync` command to save your changes.
- Reboot the switch.
- After rebooting, your switch works from your customized Layer 3 configuration with multiple VLANs per port.

Layer 3 Routing Protocols with GateD

An advanced networking configuration may require using the GateD software platform for deployment of Routing Information Protocols (RIP 1 or RIP 2) and Open Shortest Path First (OSPF) protocols. Once you've configured your Layer2 and Layer3 devices, start *gated*.

Using the Provided S55gatedRip1 Script

To use GateD protocol with the switch, you need to copy two files into the same directory as your Layer 3 configuration file. From the `/etc/rcZ.d/examples` folder, copy the example script file and its corresponding GateD configuration file (for example, `S55gatedRip1 and gated.conf.rip1`).

The example startup script executes the following commands (S55gatedRip1 is used as an

example):

- Starts GateD with Rip1 using gated.conf.rip1 as the configuration file:

```
/usr/sbin/gated –f /etc/rcZ.d/gated.conf.rip1
```

The GateD conf file specifies the following configuration commands:

- Implements the passive function so GateD is prevented from rerouting information to a different interface if insufficient information is received.

```
interface 10.0.0.42 passive

interface 10.0.1.42 passive

interface 10.0.2.42 passive

.

.

.

interface 10.0.13.42 passive

interface 10.0.14.42 passive

interface 10.0.15.42 passive
```

- Defines the netmask used in the interface.

```
define 10.0.0.42 netmask 255.255.255.0;

define 10.0.1.42 netmask 255.255.255.0;

define 10.0.2.42 netmask 255.255.255.0;

.

.

.

define 10.0.13.42 netmask 255.255.255.0;

define 10.0.14.42 netmask 255.255.255.0;

define 10.0.15.42 netmask 255.255.255.0;
```

- Sets the RIP1 protocol to open.

```
};

rip1 yes{
```

- Shuts off sending and receiving packets from all interfaces.

```
interface all noripin noripout
```

- Opens sending and receiving packets for selected interfaces.

```
interface 10.0.0.42 ripin ripout version 1;
interface 10.0.1.42 ripin ripout version 1;
interface 10.0.2.42 ripin ripout version 1;
.
.
.
interface 10.0.13.42 ripin ripout version 1;
interface 10.0.14.42 ripin ripout version 1;
interface 10.0.15.42 ripin ripout version 1;
```

- Imports routes learned through the RIP protocol.

```
import proto rip {
        all;
};
```

- Exports all directly connected routes and routes learned from the RIP protocol.

```
export proto rip {
       proto direct }
        all;
};
proto rip {
      all;
};
```

To Modify the GateD Scripts:

Copy two GateD files, the OpenArchitect "`S`" file and its corresponding conf file, into the `rcZ.d` directory (that is, `S55gatedRip1` and `gated.conf.rip1`). Notice the files are placed in the same directory as the Layer 3 configuration file.

For RIP1:

```
cp /etc/rcZ.d/examples/S55gatedRip1 /etc/rcZ.d
```

```
cp /etc/rcZ.d/examples/gated.conf.rip1 /etc/rcZ.d
```

Or for RIP2:

```
cp /etc/rcZ.d/examples/S55gatedRip2 /etc/rcZ.d
cp /etc/rcZ.d/examples/gated.conf.rip2 /etc/rcZ.d
```

Or for OSPF:

```
cp /etc/rcZ.d/examples/S55gatedOspf /etc/rcZ.d
cp /etc/rcZ.d/examples/gated.conf.ospf /etc/rcZ.d
```

- Open and make configuration changes to the listed `conf` file to coincide with the current Layer 3 configuration (that is, adjust IP addresses and number of interfaces available). See GateD documentation if you have questions regarding the `conf` file.
- Run the OpenArchitect `zsync` command to save your changes. Be sure your changes are correct.
- `zsync`
- Reboot the switch. After rebooting, your switch operates as a Layer 3 switch with GateD routing.

Class of Service (COS)

This following section provides information on using the ZNYX Networks OpenArchitect switch to provide Class of Service (COS) support. The switching fabric architecture defines the scope of the COS parameters. Some apply to an individual port, some apply to a group of ports (known as a block) and others apply to the whole switch. It is important for the user to understand the scope of the parameters to ensure that the expected behavior occurs.

Egress Queues

The base switch provides 1 to 8 COS queues per egress port, and for packets destined to the CPU from the switching fabric. By default, a freshly booted OpenArchitect switch has a single queue per egress port (and the CPU).

Ingress Classification

Incoming packets are mapped to queues based on their priority tags. The built-in behavior of the base switch uses the 802.1p tag within a packet as the queue selector. There is one COS to queue selector map per port.

By using the Linux `iptables` utility and `zfilterd` with `ztmd`, the queue selection can be based on any information in the first 64 bytes of the IP packet header. The default OpenArchitect switch behavior has all COS values mapping to a single queue on each of the egress ports.

Marking and Re-marking

The OpenArchitect switch can mark or remark packets using the TOS field or 802.1p tag. This is also controlled through the Linux `iptables` utility.

Scheduling

The servicing of configured queues by the switching fabric is referred to as scheduling. The OpenArchitect switch has three built-in scheduling algorithms. The type of scheduling algorithm used is implied, rather than being explicitly specified, based on the number of queues and which options are configured. The following scheduling algorithms are provided:

First In First Out (FIFO) – When only one queue is configured per port, packets are serviced in the order in which they arrive. This is the default for the OpenArchitect switch.

Strict Priority – This algorithm is used when more than one queue is provisioned on the port. The highest priority queue, which is also the highest numbered one, is always serviced first (Example: If four queues are configured, queue three is of higher priority than queue zero). As long as there are packets in the highest priority queue, the lower priority queues are not serviced. The danger is that higher priority traffic could block lower priority traffic.

Weighted Round Robin (WRR) – This algorithm is similar to Strict Priority scheduling, but it provides fairness with quanta for each queue. Each queue is assigned a number of packets, known as *weight*, that it is allowed to transmit before it yields to a lower priority queue. Note that with WRR, the priorities of the queues are dependent on the weights allocated. A higher priority queue with a smaller weight will get less wire-time than a lower priority queue configured with a larger weight. Note that the same *weight* applies to all queues of that priority on all ports (this is a switch-wide parameter).

The `zfilterd` and `iptables` utilities are required to map packets to queues using information other than the 802.1p tags.

zcos

zcos is a tool for examining queue and scheduling settings. It provides a means to set many of the hardware features of the switch related to class of service and differentiated services processing, including scheduling and bandwidth management. The current settings can also be examined. See the *zcos* man page in Appendix B for details on all options.

`zfilterd`

`zfilterd` is a daemon that intercepts filtering rules entered by the user via `iptables`, checks them for validity and then passes them on to `ztmd` for entry in the switch. See the `zfilterd` man page in Appendix B for details on all options.

`ztmd`

`ztmd` is traffic management daemon which accepts messages from traffic filtering and quality of service applications and sets up the hardware.

Running `zfilterd`

Before starting `zfilterd`, `ztmd` must be running. Your can start both from within a script, or directly from the command line. For example,

```
ztmd

zfilterd
```

`iptables` rules can be entered at any time. If your `iptables` filtering rules set is extensive, you may want to move your set of `iptables` commands to a start up script to run upon initialization. This could be accomplished by creating a standalone "`S`" script and placing that script into `/etc/rcZ.d` .

Restrictions on Implementation

Several restrictions exist on the rules that can be implemented on the FFP hardware. These include:

Actions

```
DROP the packet.  ACCEPT the packet.
```

Output Port

```
Should be specified if the action is ACCEPT, if no output port is
specified, an IRULE table entry is generated for every port.
```

Field values

```
If specified as ranges, they must be on power of two boundaries.
```

Negation

```
Can only be used for icmp, tcp, or udp fields.
```

Fields supported are: Source IP address, destination IP address, IP protocol, TCP or UDP source port or destination port, ICMP type, and TCP flags bits (such as SYN).

The input port and output port may also be specified as either `zre<n>`, where `<n>` is one of the 24 physical ports, or as `zhp<n>`, where the `zhp` interface used must be previously defined using `zconfig`.

A restriction on the fields supported is the size of the IMASK table. There are only 16 entries per port available, which means only 16 combinations of fields can be used at any time.

Conflict Resolution

There are differences from the expected behavior of implementing `iptables` in a host: Although the rules are taken from the FORWARD and INPUT chains, they are applied to all packets, including those destined for the local CPU. The order of application of the rules is not necessarily the order in which they appear in the chains. If a rule uses a mask that is less restrictive than another rule, it will be applied first. The last rule that is matched determines the

action that will take place. For example, the rules:

```
iptables -a FORWARD -i zhp3 -j DROP

iptables -a FORWARD -i zhp3 -o zhp1 -p tcp --dport smtp -j ACCEPT
```

result in SMTP packets received on any port in `zhp3` to be sent for any port in `zhp1`; all other packets from `zhp3` would be dropped. The order of the two rules in the FORWARD chain does not matter.

On the other hand, in the following sequence of rules, the position of the rule that drops SYN packets is important. Since the set of fields it examines is not a subset of the fields examined by the ACCEPT rules, and visa versa, the ordering rule given above does not apply. In this case, the order it is applied will be the same as its position in the FORWARD chain, and all packets which are TCP SYN packets from *zhp5* for *zhp3* will be DROPPED, even if they also match one of the ACCEPT rules.

```
iptables -a FORWARD -i zhp5 -o zhp3 -j DROP

iptables -a FORWARD -i zhp5 -o zhp3 -p tcp --sport smtp -j ACCEPT

iptables -a FORWARD -i zhp5 -o zhp3 -p udp --sport domain -j ACCEPT

iptables -a FORWARD -i zhp5 -o zhp3 -p tcp --sport domain -j ACCEPT

iptables -a FORWARD -i zhp5 -o zhp3 -p tcp --sport www -j ACCEPT

iptables -a FORWARD -i zhp5 -o zhp3 -p tcp --sport 23 -j ACCEPT # rsync

iptables -a FORWARD -i zhp5 -o zhp3 -p tcp --syn -j DROP
```

`iptables` and filtering

`iptables` is a firewall management user-space utility used in conjunction with the Linux 2.4 kernels. `iptables` takes advantage of the netfilter 2.4 kernel code.

In addition, the `iptables` utility is extended with a few more targets to support the hardware filtering functionality used in the Broadcom BCM5695 silicon on the base switch. Generally, all of the `iptables` functionality is usable with a few minor extensions.

A more detailed source on IPtables can be found at:

http://www.netfilter.org/

Almost all the contents described here are derived from there.

There are also many tutorials and `iptables` manipulation tools, both graphical and command line. This is expressive of the Open Architect concept. A good place to start is:

http://freshmeat.net/search/?q=iptables

Introduction

Firewall rules are stored in tables. These tables are sometimes also known as *firewall chains* or just *chains*. Tables normally store rules for what are known as *hooks*, which can be looked as packet-path junctions. There are five defined hooks: PRE-ROUTE, POST-ROUTE, INPUT, OUTPUT and FORWARDING. The example below illustrates the default chains on boot up.

By default, INPUT, FORWARD and OUTPUT chains are installed on boot up. Additional rules can be installed for the other chains. Additionally, one can write software extensions to add more chains. Figure 7.5 provides an illustration of firewall flow.

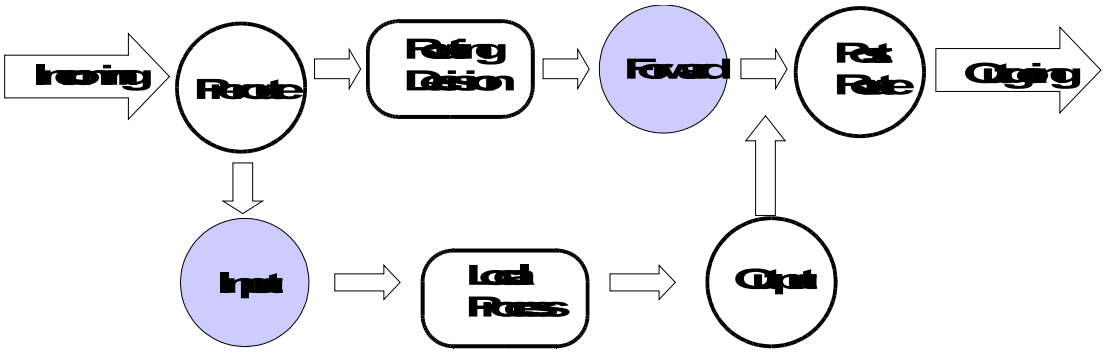


Figure 7.5: Firewall Flow

When a packet reaches a circle in the diagram, that chain is examined to decide the fate of the packet. Two basic fates of a packet are defined as DROP and ACCEPT. If the chain says to DROP the packet, it is killed there; however, if the chain says to ACCEPT the packet, it continues traversing the diagram, ultimately terminating at an application or getting forwarded out of the box. There are additional actions that can be applied to packets. These are described in the "Supported Targets" section.

A chain is a checklist of rules. Each rule is checked against the packet header and if a rule matches, action is taken. If the rule doesn't match the packet, then the next rule in the chain is consulted. Finally, if there are no more rules to consult, then the kernel looks at the chain default policy to decide what to do. In a security-conscious system, this policy usually tells the kernel to DROP the packet.

In the base switch, both the FORWARD chain hook, and the INPUT chain hook (packets destined for the CPU) are implemented in hardware. The rest of the hooks are in software in the Linux kernel. An extension of the FORWARD hook also resides in software. It is important to note that this is in sync with routing being implemented in hardware with software assist for exception handling. Under general circumstances, when routing happens in hardware, only the FORWARD chain is traversed. Under exceptional handling of an incoming packet, one can force the full software traversal. As a router you do not really care about the other hooks except in the situation where you have some special handling., in which case a policy would force the packet to be sent to the CPU for further processing.

NOTE: This is also how one would extend the OA packet munging capabilities (for example, introduce NAT).

Packet Walk

When a packet comes in via one of the interface ports, the base switch makes a routing decision. If the packet was destined for the base switch itself or if the send to CPU action is specified, it is sent to the INPUT chain for further processing. If there is no valid way to forward the packet, it is dropped. If the switch is configured to forward the packet, it is sent to the FORWARD chain.

Next the hardware FORWARD chain is walked. If there is a rule inserted that matches the packet headers, then it is looked up next. The inserted policy will decide the packets fate.

In essence, a filter rule will be used to scan the packet data for certain characteristics. Upon a match a selected 'target' is executed. The target decides what should happen to the packet.

Filter Rules Specifications

A rule could be added (`-a`) to a chain, deleted (`-D`) from a chain, replaced (`-R`) from a chain or inserted (`-I`) in a specific position in a chain. Each rule specifies a set of conditions the packet must meet, and what to do if it meets them ('what to do' is referred to as a `target').

Here's an example filter rule:

```
iptables -a FORWARD -p UDP -s 0/0 -d 10.0.0.1/32 --source-port 53 -j
DROP
```

This adds to the FORWARD chain the rule: "If you see UDP packets (-p UDP) from anywhere (-s 0/0) going to host 10.0.0.1 (-d 10.0.0.1/32) with a source port number 53 (--source-port 53) then the target is to DROP (-j DROP). More details on rule specifications follow.

Specifying Source and Destination IP Addresses

Source (`-s, --source` or `--src`) and destination (`-d, --destination` or `--dst`) IP addresses can be specified in four ways. The most common way is to use the full name, such as `localhost` or `www.linuxhq.com`. The second way is to specify the IP address such as 127.0.0.1.

Netmasks can be applied to IP addresses to specify ranges, like199.95.207.0/24 or 199.95.207.0/255.255.255.0 Both specify any IP address from 199.95.207.0 to 199.95.207.255

inclusive. To specify an all-inclusive IP address `/0` can be used, like: `-s` or `-d 0/0`. The example rule we use above applies this trick. Note, however, that the effect above is the same as not specifying the `-s` option at all.

Specifying Protocol

The protocol can be specified with the `-p` (or `--protocol`) flag. Protocol can be a number (if you know the numeric protocol values for IP) or a name for the special cases of TCP, UDP or ICMP. Case doesn't matter, so tcp works as well as TCP.

Specifying an ICMP Message Type

If the protocol is ICMP, the --icmp-type option can be used to match a specific message type, for example:

```
--icmp-type ping
```

The type can be preceded by ! to match any message except the type listed, for example:

```
--icmp-type ! 1
```

Specifying TCP or UDP ports

If the protocol is TCP or UDP, the `-s` (or `--sport`) and `-d` (or `--dport`) options specify the TCP or UDP ports to match.

A range of ports can be specified by giving the first and last ports separated by a `:`, as in `--dport 0:1023`. It is also possible to precede the port specification with a ! to match all ports which are not included in the range, for example, `--sport ! 0:1023`. However, the range of ports must be a power of two, starting with a port number which is a multiple of the range.

Specifying TCP flags

If the protocol is TCP, a match on particular TCP flags is specified by listing the flag names; for example, `-p tcp --syn`.

Specifying an Interface

The `-i` (or `--in-interface`) and `-o` (or `--out-interface`) options specify the name of an interface to match. An interface is the physical device the packet came in on (`-i`) or is going out on (`-o`). You can use the ifconfig command to list the `up' interfaces (that is, working at the moment).

As a special case, an interface name ending with a + will match all interfaces, whether they currently exist or not, which begin with that string. For example, to specify a rule which matches all `zhp` interfaces, the `-i zhp+` option would be used.

Filter Rule Targets

As mentioned above the `-j` construct within a rule specifies which target is to be used in filter rule to define a target.

Supported Targets

The following are the supported targets. The switch has many additional targets that are software based (example Network Address Translation or generic connection tracking). Please contact HP Technical support if you have additional questions on additional features.

Classical Targets

```
DROP  This drops the packet.

ACCEPT      Accepts the packet
```

ZNYX Targets

```
ZACTION     This is the ZNYX Action target.

Parameters for ZACTION:

--drop      Drops the packet

--accept    Accepts the packet

--set-prio <val>  Set the 802.1p priority to <val>

--use-prio <val>  Use queue priority <val>

--copy-cpu  Send the packet to the CPU.  This will force the full
installed chains traversal in software

--set-eport <val> Redirect the packet to port <val>

--set-mport <val> Mirror the packet to port <val>


--set-tos <val>   Set the IP-Precedence bits in the TOS field of the IP
header to <val>

--set-dscp <val>  Set the 6-bit DSCP  in the TOS field of the IP header
to <val>.

Options with any of these ZACTION parameters:

--counter <val>   Increment classifier hit counter <val>

--arp    Not an action,  match only ARP packets.

-i option can be used to specify ingress port or VLAN,

-d specifies target IP address,

-p specifies arp operation as request (1) or response (2).

For arp response, the -o field can be used to specify the egress port.
```

ZACTION Examples

Send all tcp packets arriving on zhp5 out port 2:

```
iptables -a FORWARD -i zhp5 -p tcp -j ZACTION --set-eport 2
```

Send all tcp packets arriving on zhp5 to the CPU (software).

```
iptables -a FORWARD -i zhp5 -p tcp -j ZACTION --copy-cpu
```

Set the 802.1p priority to 3 on all tcp packets arriving on zhp5.

```
iptables -a FORWARD -i zhp5 -p tcp -j ZACTION --set-prio 3
```

Extensions to the default matches

These are described in the Linux packet filtering HOWTO at:

http://netfilter.org/documentation/index.html#documentation-howto

ZNYX FORWARDING Chain supports all of them.

`tc`: Traffic Control

The switch supports up to eight queues for each port, including the cpu port. These queues hold packets waiting to be transmitted for a given port. A scheduler selects the next packet to be transmitted from one of these queues based on one of three scheduling algorithms: strict priority, round robin, and weighted round robin.

`tc`, which stands for Traffic Control, is a mechanism for enabling Quality of Service on Linux. `tc` supports the strict priority and weighted round robin algorithms, which it refers to as queuing disciplines . `tc` uses three functional objects: *queuing disciplines* (`qdiscs`), which comprise queuing and scheduling algorithms such as FIFO queues, priority queues, RED queues, and token buckets; *classes*, which are leafs in queuing discipline hierarchies; and *filters*, such as u32 filters and route filters. In addition to these three building blocks, `tc` also includes policers and meters, which may be associated with filters.

The functional elements of `tc` may be combined to produce complex QoS rules. For example, a packet may be matched to a filter, metered, policed as in-profile or out-of-profile, remarked, mapped to a FIFO queue, and transmitted by a priority scheduler. `tc` is very flexible in the data paths that it allows.

The utility `zqosd` is a daemon that monitors Linux QoS policy and shadows the policy rules into a hardware configuration. When `zqosd` is running, `tc` rules are translated into hardware rules.

NOTE: This document does not detail all of the capabilities of the `tc` command, rather it explicitly mentions only features that are supported by OpenArchitect-based switches.

The examples that follow assume that the switch is running the standard Layer 2 start-up script, `/etc/rcZ.d/examples/S50layer2`, with all ports placed in a single VLAN, `zhp0`. Note that this assumption is implied only by the fact that changes to `zhp0` are shown to configure all ports. Neither `tc` nor `zqosd` is limited by the interface setup. Each utility works on either VLANs (`zhp`) or ports (`zre`).

Strict Priority Qdisc

A typical `tc` definition of a strict priority qdisc is:

```
tc qdisc add dev zre5 handle 105: prio bands 8 priomap 0 1 2 3 4 5 6
7 0 0 0 0 0 0 0 0
```

This defines a strict priority qdisc for port `zre5` with 8 priority queues and a default mapping from 802.1p packet priority to queue. A strict priority scheduler takes packets from the highest numbered queue which is not empty. The handle is used to reference the qdisc and the individual queues which have been declared. The handle for a priority queue is formed by appending the

queue number + 1 after the qdisc handle. So the highest priority queue in this example is 105:8.

NOTE: 16 values must be provided for the priomap list. This is a feature of the Linux priority system, which uses 16 priority levels. The last eight values given will be ignored.

Weighted Round Robin Qdisc

A weighted round robin qdisc builds on the above definition by adding the list of weights which determine the order of scheduling from the queues:

```
tc qdisc add dev zre5 handle 105: prio bands 8 priomap 0 1 2 3 4 5 6
7 0 0 0 0 0 0 0 0 wrr 1 1 4 2 3 3 3 3
```

The weights apply to the eight queues in order, with the lowest numbered queue being given the first weight. The weights determine the relative number of packets which will be sent from each queue. In this example, assuming each queue has the necessary packets, the order of transmission by queue number is:

```
7 6 5 4 3 2 1 0 7 6 5 4 3 2 7 6 5 4 2 2
```

This pattern repeats as long as there are packets to be transmitted in the queues.

Although the weights can be any integer value, they will be scaled so that the largest value is 15 or less and the smallest is at least 1.

FIFO Queues (pfifo and bfifo disciplines)

The simplest configuration for `tc` involves no classes or filters, and only a single FIFO queue. With `tc`, queue sizes may be specified in bytes or packets. The first example defines a packet-limited FIFO. This example begins with only `tc` and then illustrates `tc` in conjunction with `zqosd`.

As a first step, confirm that no `tc` configuration is active on the switch, by listing any queue disciplines:

```
tc qdisc ls
```

The command should return nothing. Now, add a single packet-limited FIFO queue to `zhp0` and confirm that it has been installed to software:

```
tc qdisc add dev zhp0 handle 100:0 root pfifo limit 32
tc qdisc ls
```

The output should display the following,

```
qdisc pfifo 100: dev zhp0 limit 32p
```

The `tc` command is applied to a device, so dev `zhp0` must be specified. Note that a VLAN, such as `zhp0`, and a port, such as `zre0`, are each treated as devices. Breakdown of the options:

handle 100:0	Defines the handle for the queuing discipline. This handle may be used to reference the pfifo queue. Note that the handle is included with the output of the qdisc ls command. (100:0 and 100: are equivalent in `tc`.) The choice of handle is significant for `zqosd`.
root	Tells `tc` that this is the base queuing discipline for the device, not a child of another queuing discipline.
pfifo limit 32	Specifies a packet-limited FIFO queue with an upper bound of 32 packets.

Now, delete the queuing discipline from `zhp0` and confirm that it has been removed:

```
tc qdisc del dev zhp0 root

tc qdisc ls
```

Fifo Qdiscs

The length of the queues for each port may need to be limited to avoid filling the available memory with packets which cannot be transmitted as fast as they are received. To limit the length of a particular queue, a bfifo qdisc is defined.

```
tc qdisc add dev zre5 parent 105:1 bfifo limit 5kb
```

This limits queue 0 on `zre5` to no more than 5k bytes of data.

Using Filters to Direct Packets to a COS Queue

Once the queues are defined for a port, filters can be added to direct the desired packets into the queue. The target queue is identified by the `classid` parameter, which is the same as the handle of the cos queue. For example, to send unicast packets with a destination IP address of 10.91.100.5 to cos queue 3 created above, the filter is:

```
tc filter add dev zre5 parent 105: protocol ip u32 match ip dst
10.91.100.5/32 classid 105:4
```

Protocol ip

The u32 filter allows matching many fields of the IP packet, including: `ip src, ip dst, ip tos, ip protocol, ip sport, ip dport, ip icmp_type` and `ip icmp_code`. Each field to match except the IP addresses is specified as:

```
match <field name> <value> <mask>
```

where `<value>` and `<mask>` are numerical values. The `ip tos` field is an 8 bit field, with the ip precedence in the upper 3 bits, the type of service in the next 3 bits, and the ecn bits in the lower 2 bits. The same field can be selected as dsfiled followed by the DSCP in the upper six bits and the ecn in the remaining two bits. The mask specifies which bits are to match, so

```
match ip tos 0xa0 0xe0
```

would match an IP precedence of 5.

Specific fields can also be specified by giving their offset from the beginning of the IP header and a field name of `u8`, `u16`, or `u32`, depending on the width of the field. For example, to match the SYN bit in the TCP flags, the specification is:

```
match u8 2 0x02 at 33
```

Several IP fields can be matched in the same filter by specifying multiple match operations. The filter will be satisfied only if all matches are true. For example, to put all UDP packets from a particular IP subnet into cos queue 1, the filter might be:

```
tc filter add dev zre5 parent 105: protocol ip u32 match ip src
10.90.90.0/24 match ip protocol 17 0xFF classid 105:2
```

Protocol arp

In addition to IP packets, there is a limited capability to match other types of packets. To match an arp packet, specify protocol arp. In this case the fields which can be matched are limited to the arp operation, specified by match `u16 <operation> 0xffff at 6`, and the target IP address, specified by match `u32 <ip address> <mask> at 24`. For example:

```
tc filter add dev zre5 parent 105: protocol arp u32 match u16 1
0xFFFF at 6 match u32 0x0A5A5A65 0xFFFFFF at 24 classid 105:3
```

Protocol all

Packets with IEEE 802.3/802.2 (LLC) encapsulation can be recognized based on their DSAP/SSAP values, using protocol all. It is also possible to match the source or destination MAC address, or the VLAN. For this protocol, displacements are measured from the beginning of the MAC header, which always includes a VLAN tag after the source MAC address, so a match for DSAP 0x42 and SSAP 0x42 would be:

```
tc filter add dev zre5 parent 105: protocol all u32 match u16 0x4242
0xFFFF at 18 classid 105:5
```

To match a full MAC address, two matches are needed, since no more than 32 bit can be matched with one specification. This filter matches a source MAC address and VLAN:

```
tc filter add dev zre5 parent 105: protocol all u32 match u16 0x00c0
0xffff at 6 match u32 0x95123456 0xffffffff at 8 match u16 5 0x0fff
at 14 classid 105:7
```

Matching Specific Ingress Ports

The filters shown so far applied to all packets arriving at the switch from any of the switch ports. To restrict the filter to only apply to packets from a specific port or ports, or only arriving on a specific VLAN, an ingress queue discipline can be defined for those ports and the filter defined on that qdisc. The classid of the target then identifies both the destination port and traffic class. An ingress qdisc is very minimal:

```
tc qdisc add dev zre1 ingress //ingress qdisc for zre1

tc qdisc add dev zhp2 ingress //ingress qdisc for vlan
```

The filter add command changes slightly, the parent is now a special handle ffff:fff1, so using the same filter as the first example:

```
tc filter add dev zre1 parent ffff:fff1 protocol ip u32 match ip dst
10.91.100.5/32 classid 105:2
```

This filter will match packets arriving on port zre1, destined for port `zre5`, with destination IP address 10.91.100.5. The packets will be put in cos queue 1 on port `zre5`.

If the filter was defined for `dev zhp2` it would be applied to packets arriving on any port which is included in `zhp` 2, and require that they be in the VLAN associated with `zhp2`.

```
tc filter add dev zhp2 parent ffff:fff1 protocol ip u32 match ip
protocol 6 0xff match tcp src 0 0xf000 classid 105:3
```

This filter illustrates matching a range of values; any tcp packet on the VLAN associated with `zhp2` with a source port below 4096 will be matched.

Advanced Filtering – Policing

In addition to using filters to direct packets into particular egress queues, it is possible to measure the rate at which matching packets are arriving and specify actions to take place if the rate is "out of profile" or "in profile". This is called policing. It provides a means for limiting the bandwidth used by matching packets.

The rate threshold is specified in bytes per second, with a burst size which is to be allowed when the previous rate has been below the threshold. An action is specified to be taken only if the packet is "out of profile", that is, the rate has exceeded the threshold and burst size. A second action can be specified if the packet is "in profile"; the default is to accept the packet. A separate set of meters are used for policing on each ingress port. This means that the rates given are for each ingress port, even if the matching packets are going into a single COS queue.

A policing specification follows the match rules in a filter, and precedes the classid. The following policing specification will drop matching packets when the rate exceeds 10 million bytes per second after a burst of 20 kilobytes:

```
police rate 10mbps burst 20kb drop
```

To specify actions for in-profile packets as well as those out-of-profile, separate the actions by a "/":

```
police rate 100mbit burst 10mbit action drop/reclassify
```

The reclassify action marks the packet for dropping if the cos queue is above its congestion threshold. It would apply in this case to packets which were in profile, the out of profile packets would be dropped immediately.

The classid parameter is not required, and may not be needed for some policing filters. If it is

omitted, and the packet is not dropped, the egress queue will be determined by the priority of the packet, either from the 802.1p priority for tagged packets or the default priority for untagged packets for the ingress port.

Examples

The following commands set up priority queues for packets sent to the CPU and then use filters with policing to direct packets into these queues and limit their bandwidth.

Set up 8 strict priority queues for the cpu port (zrm)

```
tc qdisc add dev zrm root handle 124:0 prio bands 8 priomap 0 1 2 3
4 5 6 7
```

Set up bfifo qdiscs to limit the lowest 3 priority queues to 10240 bytes each

```
tc qdisc add dev zrm parent 124:1 bfifo limit 10240

tc qdisc add dev zrm parent 124:2 bfifo limit 10240

tc qdisc add dev zrm parent 124:3 bfifo limit 10240
```

Put “BPDU” packets into queue 5, limit rate to 250 kilobits/second

```
tc filter add dev zrm parent 124:0 protocol all u32 match u32
0x0180c200 0xffffffff at 0 match u16 0 0xffe0 at 4 police rate
250kbit burst 5200 action drop flowid 124:6
```

Spanning tree BPDU packets go in COS queue 6, no limit

```
tc filter add dev zrm parent 124:0 protocol all u32 match u32
0x0180c200 0xffffffff at 0 match u16 0x0001 0xffff at 4 match u16
0x4242 0xffff at 18 flowid 124:7
```

VRRP heartbeat packets go in COS queue 7, limited to 500kbits/second

```
tc filter add dev zrm parent 124:0 protocol all u32 match u32
0x0100c200 0xffffffff at 0 match u16 0x0012 0xffff at 4  police rate
500kbit burst 5200 action dropok flowid 124:8
```

Limit unicast traffic to the CPU to 20 Mbits/second, put in COS queue 0

```
tc filter add dev zrm parent 124:0 protocol all u32 match u8 0x00
0x01 at 0 police rate 20000kbit burst 250kb action dropok flowid
124:1
```

Allow pings to be received by the CPU with higher priority than other unicast packets. Give them a much lower rate

```
tc filter add dev zrm parent 124: protocol ip u32match ip protocol 1
0xFF match icmp type 8 0xFF police rate 64kbit burst 2560 drop
flowid 124:3
```

Policing Actions

Besides drop, reclassify, and ok, other actions which are permitted by the hardware can be

specified numerically for either out-of-profile or in-profile actions. The numeric value is a decimal integer action code shown in the table below. If the action requires a parameter, the parameter value is multiplied by 256 and added to the action code. Only a few of the actions are possible for out-of-profile. All can be used for in-profile.

Policing Actions		
Action	**Code**	**Out Action**
Set 802.1p priority for packet to value	64+	No
Set IP TOS field to value (IPV4 only)	66+	No
Send a copy of the packet to CPU	67	Yes
Redirect the packet to port given	69+	No
Mirror the packet to the port given	70+	No
Copy the IP TOS precedence to 802.1p priority (IPV4 only)	72	No
Copy the 802.1p priority to the IP TOS precedence (IPV4 only)	73	No
Set the Differentiated Service field to value (IPV4 only)	74+	Yes
Set the ECN to value (IPV4 only)	81+	Yes
Set the VLAN ID to value	82+	No

Table 7.2: Policing Actions

To set the DS value to 0 for out-of-profile packets and 20 for in-profile packets, use

```
action 74/5194    // 74+256*20=5194
```

To mirror only in-profile packets to port 3, use

```
action ok/838     // 70+256*3=838
```

u32 match selectors used in filters

A `u32` filter can specify multiple matches. The general form of a match is:

```
match {u32,u16,u8} <value> <mask> at <offset>
```

where `<value>` is a decimal or hexadecimal value preceded by `0x`, `<mask>` is always hexadecimal with an optional `0x`, and `<offset>` is a decimal or hex value preceded by `0x`, it is measured from the beginning of the layer 3 header or the beginning of the layer 2 header depending on the protocol. The offset must be 32 bit aligned for a `u32` match, or 16 bit aligned

for a `u16` match. In many cases, there is a field name that can be used for the match, eliminating the need to specify the offset.

U match selectors	
Field Match	**Equivalent**
ip src a.b.c.d/n	u32 <value> <mask> at 12
ip dst a.b.c.d/n	u32 <value> <mask> at 16
ip tos <value> <mask>	u8 <value> <mask> at 1
ip dsfield <value> <mask>	u8 <value> <mask> at 1
ip protocol <value> <mask>	u8 <value> <mask> at 9
ip precedence <val> <mask>	u8 <val> <mask> at 1
ip dport <value> <mask>	u16 <value> <mask> at 22
ip sport <value> <mask>	u16 <value> <mask> at 20
ip icmp_type <val> <mask>	u8 <val> <mask> at 20
ip icmp_code <val> <mask>	u8 <val> <mask> at 21
udp src <value> <mask>	u16 <value> <mask> at 20
udp dst <value> <mask>	u16 <value> <mask> at 22
tcp src <value> <mask>	u16 <value> <mask> at 20
tcp dst <value> <mask>	u16 <value> <mask> at 22
icmp type <value> <mask>	u8 <value> <mask> at 20
icmp code <value> <mask>	u8 <value> <mask> at 21

Table 7.3: U Match Selectors

Note that specifying a tcp, udp, or icmp field does not automatically include a match for the appropriate IP protocol. To insure that only the desired packets are filtered, include a match for IP protocol as well as the port or type. For example:

```
u32 match ip protocol 6 0xff match tcp dst 8 0xffff
```

Or

```
u32 match ip protocol 17 FF match ip sport 20 0xffff
```

zqosd

Thus far, `tc` has been used without `zqosd`. It is not sufficient to install software rules on the

OpenArchitect switch though, because the normal case is for packets to be switched in hardware. For that reason, `zqosd` must be used to shadow `tc` configuration into hardware. Like `zfilterd`, `zqosd` works with `ztmd`, which provides the actual hardware interaction.

If `ztmd` is not already running, start it:, then initiate the `zqosd` daemon with no parameters:

```
ztmd

zqosd
```

Now, repeat the same `tc` command as before, to install a packet-limited FIFO queue:

```
tc qdisc add dev zhp0 handle 100:0 root pfifo limit 32
```

When this command is processed, `zqosd` detects the state change and generates output.

For each port belonging to `zhp0`, the queue size has changed to 32 packets. Under the default switch configuration, all ports other than the CPU port belong to `zhp0`; so all queues other than the CPU queue are affected.

As before, remove the `tc` configuration with the command:

```
tc qdisc del dev zhp0 root
```

Note that `zqosd` detects this state change. In fact, examining the CoS configuration on the switch reveals that the queue sizes have reverted to their default values.

The byte-limited FIFO queue case differs only slightly from the packet-limited FIFO case. The syntax is almost identical. In hardware the limit is based on 128 byte cells. The specified byte limit is divided by 128 to determine the cell limit. Always specify a byte limit of at least 128 bytes to avoid setting the queue length to zero.

For example, to set the byte limit for `zhp0` to 4096,

```
tc qdisc add dev zhp0 handle 100:0 root bfifo limit 4096
```

Tear down any installed rules before proceeding with the next example:

```
tc qdisc del dev zhp0 root
```

PRIO and WRR queues

The FIFO examples used a single queue for each interface. In fact, the Ethernet Switch Blade fabric switch is capable of attaching 1 to 8 queues to each port, with either priority or weighted round robin (WRR) scheduling, and classification based on a priority map.

In `tc`, the `prio` queuing discipline establishes multiple queues and specifies their associated priority map. Although WRR support is not part of the standard `tc` distribution, it has been added to the `prio` disciplinE.

The following example illustrates WRR. A strict priority scheduler is a simpler case that can be constructed easily from this example.

Examine the existing CoS settings on the switch, noting the number of queues per port, queue sizes, scheduling parameters, and priority map. Each of these values changes with this test.

The full set of commands to install four queues, a priority map, and weights is as follows:

```
tc qdisc add dev zhp0 handle 100:0 root prio bands 4 priomap 1 2 2 2
3 3 3 3 1 1 1 1 1 1 1 1 wrr 1 2 4 6

tc qdisc add dev zhp0 parent 100:1 pfifo limit 120

tc qdisc add dev zhp0 parent 100:2 pfifo limit 100

tc qdisc add dev zhp0 parent 100:3 pfifo limit   80

tc qdisc add dev zhp0 parent 100:4 pfifo limit   60
```

The first command attaches a queuing discipline as the root discipline for `zhp0`, with a handle of "100:0," as in the FIFO cases. The "`prio`" option identifies the type of queuing discipline.

Priority scheduling implies multiple queues and the "bands 4" parameters specify that there are four queues.

The priority map may be read from left to right as `Priority n maps to Queue q`, where `n` is the index of the list element (numbering from 0) and `q` is the value specified by that element. So, this example would read:

Priority 0 maps to Queue 1

Priority 1 maps to Queue 2

Priority 2 maps to Queue 2

Priority 3 maps to Queue 2

Priority 4 maps to Queue 3

NOTE: The `tc` priority map applies to a 4-bit field. With the Ethernet Switch Blade, the priority map refers to the 802.1p tag, which is a 3-bit field. When translating this `tc` rule to hardware, only Priorities 0 through 7 are significant; the other eight priorities are ignored.

The parameters `wrr 1 2 4 6` specify that WRR scheduling is being used and assigns a relative weight to each queue. The weights are treated as numbers of packets to be sent from each queue. In this example, if the queues have sufficient packets, queue 1 will have twice as

many packets sent as queue 0, queue 2 will have four times as many, and queue 3 will have six times as many. wrr parameters are scaled such that the maximum value is no more than 15. values which would be 0 are set to 1:

- Queue 0 has a weight of 1000 bytes
- Queue 1 has a weight of 2000 bytes
- Queue 2 has a weight of 4000 bytes
- Queue 3 has a weight of 6000 bytes

The remaining commands each define a packet-limited FIFO queue. As with all previous `tc` examples, these queues are created on device `zhp0`. However, unlike all previous examples, they are not created as root disciplines for the device. Instead, the "parent" option identifies them as child queues of the `prio` discipline.

For example, "parent 100:1" identifies that queue as the first child of the `prio` discipline (Queue 0), because the `prio` discipline's handle is 100:0.

After running each of those commands, again examine the CoS parameters. As with the simple FIFO example, queue sizes change to 32 packets. In addition, though, the number of queues changes to 4 for each port in `zhp0`. Furthermore, the weights have changed for each queue, as have the queue mappings.

To test the strict priority case, simply remove the `wrr 1 2 4 6` options from the first `tc` command. Note that all queue disciplines in this test may be cleared by deleting the root discipline, as before:

```
tc qdisc del dev zhp0 root
```

The U32 Filter

The U32 filter provides the capability to match on fields in the `L2`, `L3` or `L4` header of a packet. Each match rule gives the location of the field to be tested, which is always a 32 bit word, a mask selecting the bits to be tested, and a value which is to be matched by the packet field. Many matches can be specified in one `tc` filter command. Only if all matches succeed does the filter match. In that case, the `flowid` field identifies the `classid` of the class this packet belongs in.

The following `tc` commands put all icmp packets in class 100:10, packets from IP address 1.2.3.4 in class 100:20. Packets for IP address 1.2.3.4 in class 100:20, and `arp` reply packets in class 100:30. The last filter illustrates using an offset from the beginning of the protocol header, along with a mask, to locate the field to be matched

```
tc filter add dev zhp0 protocol ip parent 100:0 u32 match ip
protocol 1 0xff flowid 100:10

tc filter add dev zhp0 protocol ip parent 100:0 u32 match ip src
1.2.3.4/32 flowid 100:20

tc filter add dev zhp0 protocol ip parent 100:0 u32 match ip dst
1.2.3.4/32 flowid 100:20
```

```
tc filter add dev zhp0 protocol arp parent 100:0 u32 match u32 2
0xffff at +4 flowid 100:30
```

Combining Queuing Disciplines

Any of the queue length limiting disciplines can be used with the bandwidth management queue disciplines, by defining them with the handle of one of the classes as their parent. For the htb queueing discipline, each class has an explicit handle specified when it is defined. For the prio queueing discipline, including `wrr`, each band is a class; their handles are formed from the handle of the prio qdisc by appending a minor number of 1 to n for the n bands. For example, the following commands define two strict priority queues for port `zre5`, with the lower priority queue limited to 32 kb and the higher priority queue limited to 32 kb:

```
tc qdisc add dev zre5 root handle 100:0 prio bands 2 priomap 0 0 0 0
1 1 1 1

tc qdisc add dev zre5 parent 100:1 handle 110:0 bfifo limit 32kb

tc qdisc add dev zre5 parent 100:2 handle 120:0 bfifo limit 32kb
```

These translation rules handle conversions of individual rules from `tc` entries into hardware entries. They do not explain the results of creating rules that are individually supported; but which do not make sense in conjunction.

Although the translation rules handle some inconsistency between software and hardware, a user must define a combination of rules that is reasonable in hardware, to ensure predictable results.

Handle Semantics

All examples have illustrated `zqosd` copying `tc` rules into hardware. In fact, the `zqosd` utility also enables the user to add `tc` rules that remain only in software. This selection is based on handles. `zqosd` processes all supported queue disciplines and filters with handles between 100:0 and 200:FFFF.

COPS: Common Open Policy Service

The Common Open Policy Service (COPS) is a protocol for distributing networking policy to devices such as switches and routers. COPS allows a single Policy Decision Point (PDP) to distribute policy to multiple Policy Enforcement Points (PEPs). A PDP acts as a server for PEP clients. Figure 7.6 provides an illustration of the COPS Network Architecture.

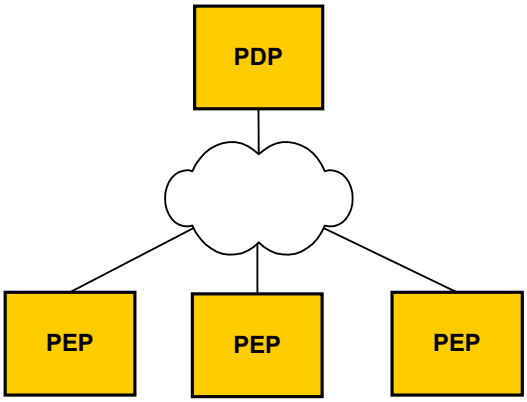


Figure 7.6: COPS Network Architecture

A PDP contains all of the policy rulers for its associated PEPs. A PDP typically stores rules in a data and is a dedicated server, not a forwarding device.

A PEP is any network device that has to enforce policy decisions. For example, a switch that restricts network access or prioritizes traffic fits the definition of a Policy Enforcement Point. A PEP makes no policy decision. It simply applies policy that receives from its PDP.

COPS uses a connection-based query and response mechanism. The following scenario illustrates PEP-PDP communication:

- A PEP comes online and opens a connection to its PDP.
- After a connection has been established, the PEP transmits state information to the PDP.
- The PDP uses that state information to determine what policy is applicable for the PEP.
- The PDP sends that policy to the PEP.
- The PEP installs the policy and applies it to future traffic.

As long as COPS is running, a connection between the PEP and PDP should stay open. A PEP could query a PDP at any time asking for a policy decision. Alternatively, an administrator could modify the policy on a PDP, which would then push any policy changes to its PEPs.

Protocol Architecture

The COPS protocol is broken into several components. The base layer is the COPS protocol itself, which defines the messaging format. This protocol defines *how* communication is handled without specifying the details of the message data.

The base COPS protocol is then used by different *client types*. These client types apply the COPS messaging scheme to particular types of data. The currently standardized client types deal with the RSVP model (COPS-RSVP) and provisioning model (COPS-PR).

The COPS-RSVP scheme is designed around the requirement that a PEP will have to query a PDP in response to events. An RSVP PEP is constantly listening for resource reservation requests

and relaying those requests to its PDP.

By contrast, the provisioning model is based on longer lasting policy. The expectation is that policy should be administratively defined at the PDP and pushed to the PEPs as needed. OpenArchitect is a COPS-PR client.

The most common use of COPS-PR is for distributing *Differentiated Services* (Diffserv) policy. Diffserv is concerned with such Quality of Service elements as queues and schedulers.

OpenArchitect PEP

The OpenArchitect PEP implementation is known as *pepd*. The *pepd* utility is based on:

RFC 2478: Common Open Policy Service (COPS)

RFC 3084: COPS Usage for Policy Provisioning

RFC 3159: Structure of Policy Provisioning Information

RFC 3289: Management Information Base (MIB) for the Differentiated Services Architecture

Internet Draft: Differentiated Services Quality of Service Policy Information Base (latest version draft-ietf-diffserv-pib-09)

Internet Draft: Framework Policy Information Base (latest version draft-ietf-rap-frameworkpib-09)

A Policy Information Base (PIB) defines the representation of a particular data set. For example, the Diffserv PIB specifies the structures used to represent all Diffserv elements. PIBs are functionally equivalent to Management Information Bases (MIBs) such as those used by SNMP. The OA PEP has implemented those portions of the Diffserv and Framework PIBs that are supported by the underlying switch architecture.

The `pepd` utility requires a PDP that has implemented the above RFCs and drafts. Until all draft standards are approved, the certain COPS-PR data types will not be assigned OIDs. pepd uses non-standard OIDs for the unassigned values.

Using `pepd`

The `pepd` utility works by connection to a PDP, informing the PDP of its *roles*, and installing any rules that the PDP has for those roles. Configuration information should be specified in a configuration file, specified on the command line with the –f option.

```
pepd –f <full_path_and_filename>
```

A sample configuration file is listed below:

```
PDP address: 10.0.0.11
PDP port: 3288
PEPID: some-id
Role-If: a zre1,zre2,zre3,zre4
```

where,

PDP address:
The IP address of the PDP. Default is loopback (127.0.0.1)

PDP port:
The destination port on which to open a COPS connection. Default is 3288.

PEPID: The PEP Identifier

Role-If: A mapping of roles to interfaces. The name of the role is followed by a comma-delineated list of interfaces. Multiple role-interface mappings are defined through multiple Role-If declarations.

Chapter 8 Base Switch Administration

One of the main benefits of the OpenArchitect switch is that it runs Linux, so much of the switch administration is already familiar to most network or system administrators. It is a good idea to complement these instructions with a standard Linux reference guide, such as *Linux Network Administrator's Guide* available from O'Reilly. Below are brief descriptions of some of the more routine administrative task pertinent to the switch.

Setting the Root Password

The switch is shipped with a default user root and no password. To set the root password, use the password command:

```
ZX6000-OA<release no.># passwd

Changing password for root

Enter the new password (minimum of 5, maximum of 8 characters)

Please use a combination of upper and lower case letters and numbers.

Enter new password:

Re-enter new password:

Password changed.

ZX6000-OA<release no.>#
```

CAUTION: Even when just changing the password, you need to save the file system overlay with the `zsync` command, or you will lose your changes upon reboot.

Adding Additional Users

Additional users can be added with the `adduser` command. Additional users are desirable for connecting to the switch via `ftpd` and other daemons that require a login other than root and a password. To create a user named guest, run `adduser`

```
ZX6000-OA<release no.># adduser guest

Changing password for guest

Enter the new password (minimum of 5, maximum of 8 characters)

Please use a combination of upper and lower case letters and numbers.

Enter new password:

Re-enter new password:

Password changed.
```

```
ZX6000-OA<release no.># zsync

ZX6000-OA<release no.>#
```

Setting up a Default Route

If you wish to access the switch from some place other than a directly attached network, you may want to setup a default route. Use the route command to set a default gateway.

```
route add default gw 10.0.0.254
```

Put the entry into the `/etc/init.d/rcS` startup script to automatically set a default route upon reboot.

Name Service Resolution

Name service lookups will be done locally using `/etc/hosts`. You can also tell the switch which name server to use by including an entry in `/etc/resolv.conf`.

DHCP Client Configuration

A utility is included to dynamically determine the IP address of the OpenArchitect switch interfaces. To set the the IP address dynamically, execute the command,

```
dhclient zhp0
```

The default device name, `zhp0`, works with the default configuration of the OpenArchitect switch and will attempt to obtain an IP address from the local DHCP server. To use DHCP to set your IP addresses automatically on boot up, uncomment the the following line in `/etc/init.d/rcS` by removing the `#` sign:

```
/usr/sbin/dhclient zhp0
```

DHCP Server Configuration

The OpenArchitect switch includes a DHCP server. To start the DHCP server, configure `/etc/dhcpd.conf` for your network, and run `dhcpd`

Consult Linux Network administration manuals for more information on DHCP and configuration options.

To use DHCP to set your IP addresses automatically on boot up, uncomment the the following line in `/etc/init.d/rcS` by removing the `#` sign:

```
dhcpd
```

Network Time Protocol (NTP) Client Configuration

NTP is a protocol for setting the real time clock on a system. There are numerous primary and secondary servers available on the network. For more NTP information, and a list of available NTP servers, see the following URL:

http://www.ntp.org/

You will need to have your network settings properly configured to reach an available NTP server on your local network or the Internet. To set the time and date, execute `ntpdate` with the server of your choice. For example:

```
ntpdate -u ntp.ucsd.edu
```

The `-u` is required if the OpenArchitect switch is operating behind some types of firewalls.

If you wish for `ntpdate` to set your date and time automatically each time you boot, uncomment the example `ntpdate` command line in `/etc/init.d/rcS` by removing the `#` sign. `ntpdate` returns the Universal Time (UTC, formerly Greenwich Mean Time, or GMT). To display the local time, set the TZ variable to the appropriate name and the number of hours offset from UTC. For instance:

```
export TZ=PST8
```

for Pacific Standard Time offset from UTC by 8 hours. To set an environment variable, add the entry to `/etc/profile`. Remember to `zsync` to make your changes permanent.

Network File System (NFS) Client Configuration

The OpenArchitect switch includes an NFS client for mounting remote file systems. You will need to start NFS server processes in order to use NFS. You will need to start the following servers:

```
/sbin/portmap

/sbin/rpc.statd

/usr/sbin/rpc.mountd -r
```

Once the above servers are started, you can mount a remote NFS file system.

```
mount rhost:nfs_file_system local_mount_point
```

If the remote NFS file system you're mounting is on an OA switch, you should mount with caching disabled.

```
mount rhost:nfs_file_system -o noac local_mount_point
```

All the necessary servers are included in /etc/init.d/rcS but are commented out by default. To automatically start all NFS client services each time you boot, uncomment the NFS Client servers. Go to the /etc/init.d/rcS file. Uncomment the following command lines by removing the # sign.

```
/sbin/portmap

/sbin/rpc.statd

/usr/sbin/rpc.mountd -r
```

You can also include commands to mount remote NFS file systems at boot time. There is an example line included at the appropriate location in /etc/init.d/rcS. Uncomment and alter the mount command included for your particular configuration.

NOTE: A "sleep" of 5 seconds is included to allow time for the links to come up prior to attempting the mount.

```
sleep 5

mount 10.0.0.1:/nfs –t nfs –o noac /mnt
```

NFS Server Configuration

The switch also contains an NFS server so that you can mount the switch file system from other systems. To enable the NFS server, first follow the steps to enable the NFS client. Then, edit

/etc/exports to include the file systems you wish to export. Consult a standard Linux Network Administrator's Guide (or man pages) regarding options for exported file systems. Generally, an

entry in /etc/exports looks like the following:

```
/nfs        *.localdomain.com(ro)
```

Now start nfsd to export the mount points and begin answering requests from remote clients.

```
/sbin/rpc.nfsd –r
```

To export file systems automatically on boot, edit /etc/init.d/rcS, uncomment the /sbin/rpc.nfsd command line by removing the #.

```
/sbin/rpc.nfsd -r
```

Connecting to the Switch Using FTP

Use ftp to transfer files to or from the switch. See the Linux Reference Guide for details of the ftp command. In general, you can use ftp to connect to any system running an ftp server, including other OpenArchitect switches, to either get (transfer files from the remote host to the switch) or put (transfer files from the switch to the remote host) files.

```
ftp <remote_host>
```

`ftpd` Server Configuration

The switch itself can also be configured to run an FTP server (`ftpd`). See the Linux Reference Guide for details of the `ftpd` command. You will need to add a user to the switch in order to connect via ftp from a remote host, since root is not allowed ftp access. See the earlier section in this chapter regarding how to add a user. The `ftp` daemon is started by default. If you wish to shutdown the ftp daemon, comment out the betaftpd line in `/etc/init.d/rcS`.

Connecting to the Switch Using TFTP

Trivial File Transfer Protocol or TFTP, is a very simple protocol used to transfer files. It is designed to be small and easy to implement. Therefore, it lacks most of the features of a regular FTP, like user authentication. You can use `tftp` to connect to any system running a TFTP server (`tftp`) including other OpenArchitect switches.

```
tftp <remote_host>
```

TFTPD Server Configuration

The TFTP server is started by `inetd(8)` using the configuration set up in `/etc/inetd.conf`. The use of `tftp(1)` does not require an account or password on the remote system. Due to the lack of authentication information, *`tftpd`* will allow only publicly readable files to be accessed. The default location of these files is `/tftpboot`.

SNMP Agent

Simple Network Management Protocol (SNMP) is the defacto standard for network management. An SNMP agent maintains a structure of data for a network device in a virtual information database, called a Management Information Base (MIB). A network management station is capable of accessing the MIB of the network device to monitor and configure the network device.

The OpenArchitect switch utilizes the NET-SNMP (formerly UCD-SNMP) agent core. Additional information on the agent can be found at: http://www.net-snmp.com. The OpenArchitect switch agent will respond to SNMPv1, SNMPv2, and SNMPv3 requests.

Protocols supported on the OpenArchitect switch by *gated*, such as RIP and OSPF communicate with SNMP agent via the SNMP Multiplexing (SMUX) protocol.

Supported MIBS

OpenArchitect includes MIB support as documented by each of the RFCs listed. The MIBs themselves are located on the switch in the `/usr/share/snmp/mibs directory`.

Supported MIBS	
RFC 1155:	Structure and Identification of Management Information for TCP/IP-based internets
RFC 1227:	SNMP MUX Protocol and MIB
RFC 1493:	Definitions of Managed Objects for Bridges (obsoletes RFC 1286)
RFC 1657:	Definitions of Managed Objects for the Fourth Version of the Border Gateway Protocol (BGP-4) using SMI-V2
RFC 1724:	RIP Version 2 MIB Extension (obsoletes RFC 1389)
RFC 1850:	OSPF Version 2 Management Information Base (obsoletes RFC 1253, which obsoletes RFC 1252, which obsoletes RFC 1248)
RFC 2011:	SNMPv2 Management Information Base for the Internet Protocol Using SMIv2
RFC 2012:	SNMPv2 Management Information Base for the Transmission Control Protocol Using SMIv2
RFC 2012:	SNMPv2 Management Information Base for the User Datagram Protocol Using SMIv2
RFC 2013:	Management Information Base for Network Management of TCP/IP-based internets: MIB-II (obsoletes RFC 1213, which obsoletes RFC 1158)
RFC 2021:	Remote Network Monitoring Management Information Base Version 2
RFC 2096:	IP Forwarding Table MIB
RFC 2571:	An Architecture for Describing SNMP Management Frameworks
RFC 2572:	Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)
RFC 2573:	SNMP Applications
RFC 2574:	User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)
RFC 2575:	View-based Security Model (VACM) for version 3 of the Simple Network Management Protocol (SNMP)
RFC 2576:	Coexistence between Version 1, Version 2 and Version 3 of the Internet-standard Network Management Framework
RFC 2665:	Definitions of Managed Objects for Ethernet-like Interfaces
RFC 2674:	Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions
RFC 2742:	Definitions of Managed Objects for Extensible SNMP Agents
RFC 2787:	Definitions of Managed Objects for the Virtual Router Redundancy Protocol
RFC 2819:	Remote Network Monitoring Management Information Base
RFC 2863:	The Interfaces Group MIB (obsoletes RFC 2233, which obsoletes RFC 1573, which obsoletes RFC1229)
RFC 2932:	IPv4 Multicast Routing MIB
RFC 3165:	Definitions of Managed Objects for the Delegation of Management Scripts
RFC 3231:	Definitions of Managed Objects for Scheduling Management Operations

Supported MIBS	
ZNYX Networks Private MIB	Custom ZNYX MIB to support software and hardware features not covered by standard MIBs. The Private MIBs are ZX7100BASE.MIB AND ZX7100FABRIC.MIB, pointed to by ZNYX-H.MIB.
UCD-SNMP Enterprise MIB	UCD-SNMP MIB related to management and monitoring of the LINUX host

Table 8.1: Supported MIBs

Supported Traps

Upon certain events, the OpenArchitect switch can be configured to send notification of the event, called an SNMP Trap out to a defined recipient/manager or managers. Traps are not issued in real time. OpenArchitect will send SNMP traps for the following conditions:

Supported Traps	
SNMPv2-MIB:	coldStart
SNMPv2-MIB:	authenticationFailure
IF-MIB:	linkUp
IF-MIB:	linkDown
UCD-SNMP-MIB:	ucdShutdown
RMON-MIB:	risingAlarm
RMON-MIB:	fallingAlarm
VRRP:	vrrpTrapNewMaster
VRRP:	vrrpTrapAuthFailure
EGP (rfc1213):	egpNeighborLoss
BGP4-MIB:	bgpEstablished
BGP4-MIB:	bgpBackwardTransition

Table 8.2: Supported Traps

SNMP and OpenArchitect Interface Definitions

OpenArchitect, defines three types of devices:

```
zre   physical port

zrl   trunk of ports

zhp   interface consisting of ports (zres) and trunks of ports (zrls)
```

A `zrl` (trunk device) is treated as an aggregate of its constituent `zres` (ports). A `zhp` is an aggregate of its immediately contributing sub-interfaces (`zres` and `zrls`). The ports that make up a trunk do not contribute to the `zhp`.

The administrative status of a `zre` and `zhp` are independent of each other. If the administrative

status is down, then the operational status will be down independent of the underlying link state. You must `ifconfig` up the `zres` to see the operational link status for a `zre`. When the administrative status is up, the operational status is dependent on the underlying physical state. For example, Table 8.3 shows that if `zhp0` contains `zre1` and `zre2`, the it would also be true for the operational status (given the administrative status is up on `zre1`, `zre2`, and `zhp0`).

Link and SNMP Status				
Physical Link Status		**SNMP Operational Status**		
zre1	**zre2**	**zre1**	**zre2**	**zhp0**
down	down	down	down	down
down	up	down	up	up
up	down	up	down	up
up	up	up	up	up

Table 8.3: Physical Link Status on Base Switch

The administrative status is directly controlled by `ifconfig` up/down. The administrative status of the `zhps` and `zres` do not affect each other.

`ifStackTable` Entries

In the actual ifStackTable as shown in the MIB walk the following two OIDs (which denote ifIndexes) show the relationships.

```
ifMIB.ifMIBObjects.ifStackTable.ifStackEntry.ifStackStatus.0.1 =
active(1)

ifMIB.ifMIBObjects.ifStackTable.ifStackEntry.ifStackStatus.0.2 =
active(1)
```

If they are X.Y then

- if X = 0 there is nothing "above" this interface
- if Y = 0 there is nothing "below" this interface

otherwise interface X has interface Y as a logical constituent.

SNMP Configuration

The SNMP agent is called snmpd and is started by default from the Linux boot up script `/etc/rcZ.d/S75snmpd`. If you do not wish to start `snmpd`, remove `/etc/rcZ.d/S75snmpd`.

Configuration of the OpenArchitect switch SNMP agent is the same as configuration of any standard Linux host that uses the NET-SNMP agent. Configuration information for persistent data and security information is kept in `snmpd.conf` under the default SNMP configuration location, which for the OpenArchitect switch is `/usr/share/snmp. snmpd.conf` is the location to change “sys” information such as the `syslocation` and `syscontact`, as well as permissions such as the `rocommunity` or `rwcommunity`.

IMPORTANT: For NET-SNMP agents, these objects (`sysLocation.0`, `sysContact.0` and `sysName.0`) ordinarily are read-write. However, specifying the value for one of these objects by giving the appropriate token in snmpd.conf makes the corresponding object read-only, and attempts to set the value of the object will result in a notWritable error response.

The processing for link up and link down traps is now user configurable. As the default, traps conform to RFC2863, meaning the trap contents will include:

`ifIndex, ifAdminStatus` and `ifOperstatus`

You can alter this behavior by specifying:

```
cisco_link_traps on
```

If `cisco_link_traps` are turned on as described then link up and link down traps will have a cisco-like format and the trap contents will include:

`ifDescr and ifType`

Examine and edit `/usr/share/snmp/snmpd.conf` appropriately for your configuration. Information in `/usr/share/snmp/snmpd.conf` is only read at startup - or when the daemon is forced to reread its configuration. See the standard Linux man page for `snmpd.conf` for more details.

SNMP Applications

The OpenArchitect switch includes the `snmpget`, `snmpwalk`, and `snmpset` applications you can use these standard Linux utilities to test your SNMP agent. For example,

```
snmpwalk localhost -c public
```

walks the entire MIB of the localhost (OpenArchitect switch) starting at the top of the MIB. See the *Linux Reference Man Pages* for the usage of the SNMP utilities.

MIB values are decoded from their numerical representations into readable text by parsing MIBs located in the `/usr/share/snmp/mibs/` directory. If you need to add a MIB, add it to that directory and `zsync` to save across reboots.

Port Mirroring

`zmirror` sets packet mirroring from a given set of ports to a given port. Turning on packet mirroring causes a copy of the packet to be sent to the `mirror_to` port. There can be only a single `mirror_to` port, but there can be multiple `mirror_from` ports. The `zmirror` command overwrites the `mirror_to` port. The `zmirror` command accumulates the `mirror_from` ports. Note, there are performance issues when trying to mirror more bandwidth than is available on the `mirror_to` port. Use the `zmirror` command in the following way:

```
zmirror mirror_from mirror_to
```

After executing the following three commands, packets received on ports 0, 1 and 2 would be mirrored (copied and transmitted) to port 12. This mirroring would be in addition to any Layer 3 or Layer 2 switching.

```
zmirror zre0 zre12

zmirror zre1 zre12

zmirror zre2 zre12
```

To clear the current mirroring use the `-t` option. The `-e` option can be used to indicate that packets being sent on a given port should be copied to the `mirror_to` port. For example if the `-e` option is used as follows, the packets transmitted, as opposed to received, on ports 0, 1 or 2 would be mirrored to port 12.

```
zmirror -e zre0 zre12

zmirror -e zre1 zre12

zmirror -e zre2 zre12
```

Link and LED Control

The `zlc` application sets the link speed and state of individual ports of the switch, or display their current state. It can also set or clear the extract led or the internal fault led, or to set a port down or up. To force the link on port 0 down,

```
zlc zre1 down
```

To check the status of a link,

```
zlc zre1 query
```

To check the status of all links,

```
zlc zre0..23 query
```

Link Event Monitoring

The `zlmd` application is intended to run as a daemon, waiting for a configured event to occur and then running the program configured for that event. The events monitored are changes in the link status at any of the 24 in-band ports of the switch, the start of removal of the switch from the backplane, or the cancellation of the removal before it actually takes place. The program can be a shell script that initiates appropriate actions to respond to the event.

Chapter 9 Base Switch Maintenance

This chapter includes basic information about the OpenArchitect switch environment including an overview of the file system structure, modifying and updating switch files, upgrading the switch driver and kernel, and implementing a system recovery.

Overview of the OpenArchitect switch boot process

The OpenArchitect switch is equipped with a Random Access Memory (RAM) disk and three Read Only Memory (ROM) devices, including, a boot ROM and two application flash

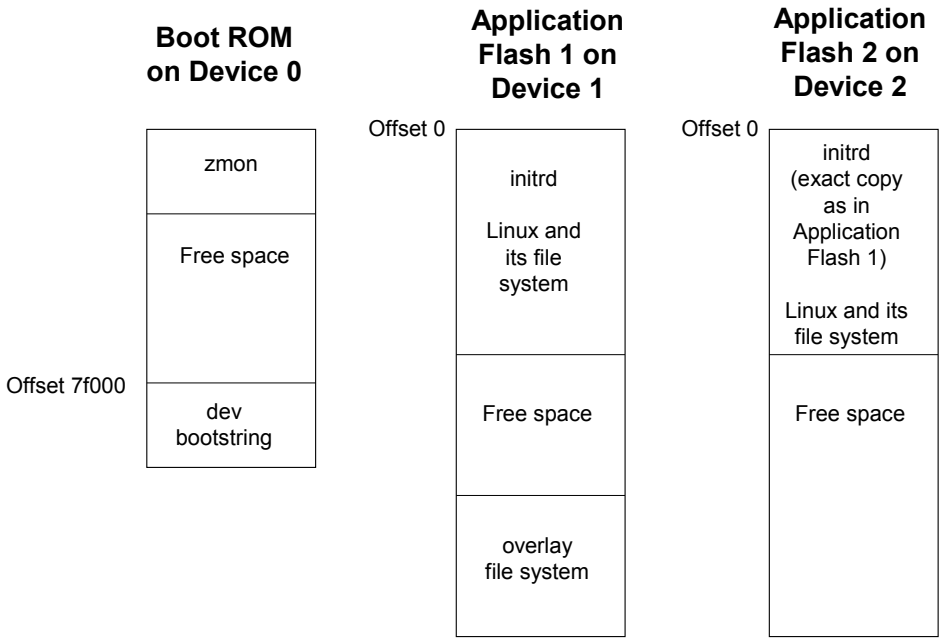


Figure 9.1: ROM Devices in OpenArchitect

The boot ROM is located on device 0 and contains the OpenArchitect `zmon` application that operates as a boot loader and includes a device bootstring. Device 1 contains the application flash 1 image of the Linux operating system and the OpenArchitect overlay file system. Application flash 1 is the primary working image for the switch. Device 2 contains the application flash 2 that is an exact copy of application flash 1. You would only boot from this device if application flash 1 is corrupted and you need to restore the switch to the factory-shipped configuration.

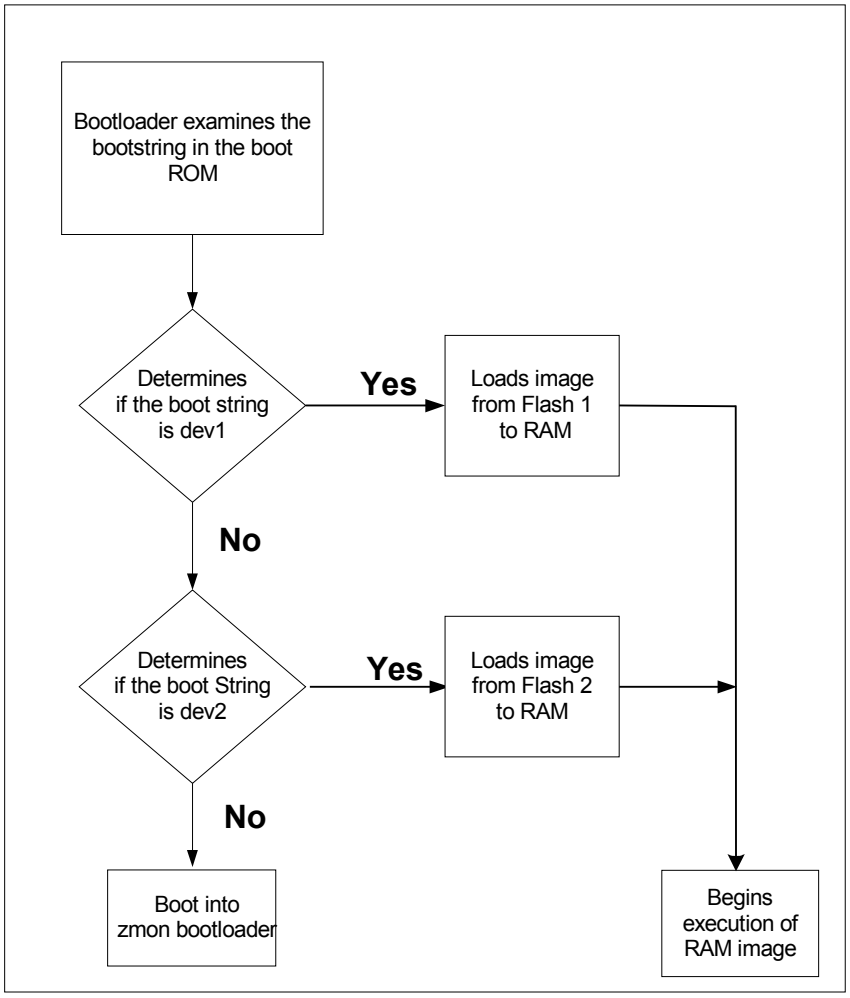


Figure 9.2: Booting up Process Flow

Under normal circumstances, the booting up process follows the process outlined in Figure 6-2. During boot up, the `zmon` bootloader reads the device bootstring to locate and validate the correct application image to load. The bootstring command is in the following format:

boot : X | [<options>] X represents the device value 0, 1 or 2

The boot process opens and uncompresses the initrd image onto the RAM disk. Then zmon begins booting the Linux image. After Linux boots, the init process executes the `/etc/init.d/rcS script` which, in turn, executes `/etc/rcZ.d/rc` (see Figure 9.3: Init Script Flow*)*). The `/etc/rcZ.d/rc` script runs `S*` files in `/etc/rcZ.d`, with the start parameter. The `S*` files are the switch configuration files (for example, `S50layer2`).

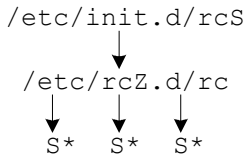


Figure 9.3: Init Script Flow

Saving Changes

Any modifications made to the scripts for your particular configuration must be properly saved or your changes are lost when you reboot. The file system for the switch only exists in memory. A rewritable overlay is contained within the upper four megabytes of the first application flash.

Modifying Files and Updating the Switch

Any file in OpenArchitect can be added, deleted or modified, with the exception of `/sbin/init`, `/usr/sbin/zmnt`, `/lib/modules/zfm_c.o`, and the `/tmp directory`. Files are saved across a system reboot by running the script `zsync`.

A directory `/.zsync` contains database files used by `zsync` for managing the file system overlaying process. The user should not modify the files in this directory or unpredictable results may occur.

Recovering from a System Failure

If the switch does not function after you initially change or reconfigure the image, you have several options for recovering from an error. First, try to `telnet` into the switch. If you are successful, remember to run `zsync` after fixing your problem.

If you cannot `telnet`, attach a console cable to the switch. Bring down the system and properly attach the console cable, see *Chapter 2, Connecting to the Console Port* .

System Boots with a Console Cable

After attaching the system console cable, if the system boots, fix the problem that does not allow you to telnet to the box, run `zsync`, and reboot. The problem is likely to be in the configuration files contained in `/etc/rcZ.d` In order to telnet into the box, there must be a configured interface with a proper IP address. For example, `zhp0` is configured with the IP address 10.0.0.42 in the factory default configuration.

Booting with the –i option

If you cannot `telnet` into the switch and Linux fails to boot, it is likely that a change saved by `zsync` has left the switch in an inaccessible state. To allow users to recover from mistakes saved in the overlay file system, a boot argument of `-i` passed to the `init` process will stop the untarring of the saved overlay files. As a result, the system boots to the factory-shipped configuration.

- Connect through the console port. During boot up, the system displays the Linux boot string. "Linux/PPC load: " for 5 seconds. During the 5 second pause, enter the boot option "`-i`" and press Return

```
Linux/PPC load: root=/dev/ram init=/sbin/init -i
```

- Initiating the *–i* option of `zbootcfg`.

```
zbootcfg –d 1 –i
```

- Reboot the system. After the reboot, clear the `–i` option from the boot string. Enter the following command:

```
zbootcfg –d 1
```

The reboot command will also take "`-i`" as an option and pass it to the Linux boot,

```
reboot -i
```

- When the system boots, the overlay file system is returned to the factory-installed configuration. At this point, you have a few options.
- Run `zsync` and the factory-installed system will be restored to your flash.

  NOTE: All changes you have made and saved prior to the `zsync` command will be lost.

- Restore particular files from the existing overlay. Use the `zmnt` command to mount the overlay in a designated directory and copy back just the changes you want to keep from the existing overlay. For example, if you wanted to recover your `/etc/hosts` file from the existing overlay, use `zmnt` to mount the overlay in a designated directory, like `/tmp`, then copy `/tmp/etc/hosts` to `/etc/hosts`. Lastly, use `zsync` to save your changes.

```
zmnt /tmp

cp /tmp/etc/hosts /etc/hosts

zsync /etc/hosts
```

- Reboot the system.

System Hangs During Boot

After attaching the system console cable, if the system hangs during boot, try booting with the `-i` option as described in the previous section. It is possible that important Linux system files became corrupted and incorrectly saved in the flash overlay. Use `zmnt` as described in the previous section to fix or remove the problem files from the overlay. If the system will not boot with the `-i` option, refer to *Booting the Duplicate Flash Image* section in this chapter.

Booting the Duplicate Flash Image

Another recovery method, if Linux fails to boot, is to temporarily boot the factory-installed duplicate image located in the second flash device.

Connect through the console port.

When you see the number counter appear after the "zmonitor …" banner, press any key on the console keyboard to enter the `zmon` application.

At the monitor prompt, type:

```
boot:2
```

You should see the counter again, but the system should boot into the secondary kernel. If you have difficulties booting, contact Hewlett-Packard Technical Support.

At this point, follow the *Upgrading the OpenArchitect Image* section to put a new RAM disk image in the application flash 1.

IMPORTANT: Be sure not to program flash 2, since this is your only current bootable image.

The command to program flash 1 should be similar to the following command. The image name may be slightly different depending on the model of switch and version of the image:

```
zflash -d 1 rdr6000.zImage.initrd
```

Upgrading the OpenArchitect Image

1. Refer to the *HP bh5700 14-Slot Blade Server Installation Guide*, *Chapter 6, 14-Slot Shelf Startup, Validating and Updating Your Firmware* for instructions on how to gain access to firmware updates for the HP bh5700 14-Slot Blade Server.
2. Use telnet, or preferably, attach a console cable to the switch, and login to the switch.

   I**MPORTANT: If you are connecting via `telnet`, be aware that the upgrade process will reset the switch to the default IP address of 10.0.0.42, so you will have to be able to reach 10.0.0.42.**
3. Using the procedures referenced in Step 1, above, download the available OpenArchitect image upgrade to a local system.
4. Check for free space with the `df` command. The OpenArchitect image is very close to

the limit of free space available on a default system, so you may need to clear some space prior to downloading the new OpenArchitect image to the switch.

CAUTION: Do not remove the existing copy of `/usr/sbin/gated` (as suggested in Step 5, below) until you have, in fact, determined that an OpenArchitect upgrade version is available for downloading.

5. One of the easiest ways to create free space is to remove `/usr/sbin/gated`, as the application will be replaced during the update procedure. Once you have enough free space, proceed.
6. From the switch console, `ftp` the new OpenArchitect (rdr) image from the local system to your switch.
7. The switch has two flash available: Device 1 and device 2. Use the `zflash` command to write the new OpenArchitect image into the first flash device.

IMPORTANT: Make sure that Surviving Partner is not running before using `zflash`. The delays incurred while `zflash` writes the flash can cause the Surviving Partner daemons to think there is a failure, resulting in link oscillation.

```
zflash -d 1 <image_file>
```

The image file will be something named similar to the following,

```
zflash -d 1 rdr6000.zImage.initrd
```

Upgrading or Adding Files

Follow the procedure below to upgrade or add a new file to the switch. Place the file you are adding or upgrading into the appropriate location in the file system. Save the file in the overlay directory area on the application flash by running `zsync`.

```
zsync
```

After running `zsync`, the file is saved to the flash for future reboots.

Excluding Saving Files to Flash

Specific files or directories can be excluded from saving to flash by `zsync` by including an entry in `/etc/exclude`. Likewise, existing entries in `/etc/exclude` such as `/tmp` can be removed in order to save those files to flash with `zsync`.

Upgrading the Switch Driver

The switch driver upgrade process is the same as a file upgrade. However, more caution should be taken since the driver module is likely to be the method by which you are logging into the system. If the switch driver has a problem, you will need to have a console cable to recover. To upgrade a switch driver, replace the file `/lib/modules/if_zxe.o`, run `zsync` and reboot.

Using `apt-get`

`apt-get` is a utility created by the Debian Linux community to allow remote fetching and installation of software stored in a repository in Debian package format. It allows users to keep their software up-to-date with the latest binaries, and install new software without the need to recompile.

Users may create their own repositories and add entries in `/etc/apt/sources.list` (empty by default) for their private access methods to their private repository. See `http://www.debian.org` for complete APT documentation.

Chapter 10 Connecting to the Ethernet Switch Blade

The Ethernet Switch Blade has two completely separate switching subsystems within one ATCA blade supporting both Base Interface and Fabric Interfaces

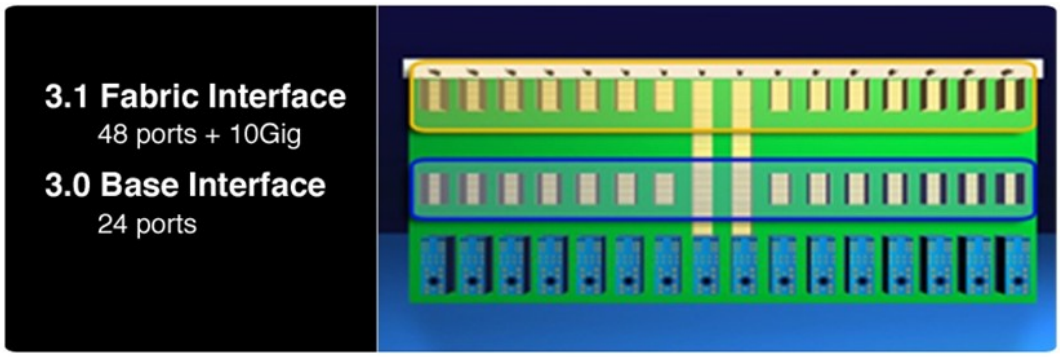


Figure 10.1: Fabric and Base

The Ethernet Switch Blade implements an independent control processor and software environment for both Base and Fabric Interface switching subsystems. Troubleshooting problems are similar in both environments. The following sections provides instruction on how to connect to the Serial Port or Out-of-Band (OOB) Ethernet Interface for each backplane interface type if user-intervention is needed.

Base Interface Hub System:

A 24 port Gigabit Ethernet Switch that provides service for a full 14-slot ATCA chassis. All connectors for the base interface hub and it's processor are labeled "base".

Ethernet Interfaces:

The 3.0 Base Interface switching system provides 24 ports of Gigabit Ethernet service for up to 14 line cards with support for dual-shelf manager connections. Three ingress/egress ports are available on the front panel. An additional Gigabit Ethernet port (ISL) on the backplane interconnects the switches together for high availability configurations. If the OpenArchitect environment is running, any in-band port can be used to establish a Telnet session.

Management Interfaces:

The Ethernet Switch Blade features an RS-232 console port located on the front panel that allows communication with the switch when the Out-of-Band Ethernet port is not available, or in-band Ethernet service cannot be established with the switch. A hyperterminal application is recommended to contact the Ethernet Switch Blade through a Telnet session when using the

console port. An RS-232 to RJ-45 adapter is required.

Fabric Interface Hub System:

A 48-port Gigabit Ethernet Switch that provides PICMG 3.1 Option 2 (2.0 Gb/s) Ethernet service for a full 14-slot ATCA chassis. All connectors for the fabric interface hub and it's processor are labeled "fabric".

Ethernet Interfaces:

The 3.1 Fabric Interface switching system provides 48 ports of Gigabit Ethernet service with PICMG 3.1 option 2 (2.0 Gb/s) links for all line cards installed and option 3 (4.0 Gb/s) for up to 6 slots. Four ingress/egress ports are available on the front panel. An additional Gigabit Ethernet port (ISL) on the backplane interconnects the switches together for high availability configurations. If the OpenArchitect environment is running, any in-band port can be used to establish a telnet session.

Management Interfaces:

The Ethernet Switch Blade features a RS-232 console port located on the front panel that allows communication with the switch when the Out-of-Band Ethernet port is not available or in-band Ethernet service cannot be established with the switch. A hyperterminal application is recommended to contact the Ethernet Switch Blade through a telnet session when using the console port. An RS-232 to RJ-45 adapter is required.

Connecting to the Base Interface

Base Interface Serial Port Connection

The switch console can be accessed via a RJ-45 10/100 service port located on the front panel of the Ethernet Switch Blade. The RS-232 RJ-45 console port may be used to recover from a system failure. It is used for maintenance only and is generally not connected.

An RS-232 to RJ-45 adapter cable is required to connect to the console port of the switch.

Figure 10.2 Shows the RJ-45 serial console (1) and Out-of-Band (OOB) ports (2) for the Base Interface.

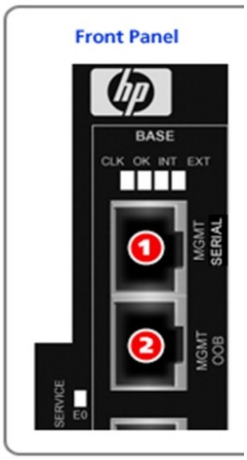


Figure 10.2: Base Interface Serial Port

To attach the console cable to the Ethernet Switch Blade switch:

1. Plug the RJ-45 end of the console cable (P/N 6900-63006, shipped with the HP bh5700 ATCA 14-Slot Blade Server) into the RJ-45 Console Port (1) on the front panel.
2. Connect the DB-9 end of console cable into a standard Modem Eliminator Cable (normally locally available).
3. Connect the DB-9 header on the other end of the Modem Eliminator Cable to a standard COM port on your PC or laptop computer (9600, n, 8, 1).
4. Reinsert the switch into the system and power up.
5. Use a terminal emulation program to access the switch console.

Base Interface Out-of-Band Ethernet Connection

Connect an Ethernet cable from the Ethernet Switch Blade front panel MGMT OOB (2 in Figure 10.2) to your PC.

1. Configure a host on the 10.0.0.0 network.
2. The OpenArchitect switch is pre-configured with address 10.0.0.42. `telnet` to 10.0.0.42.

   ```
   telnet 10.0.0.42
   ```

3. After you are connected, enter the login name `root`. No password is required.

   ```
   OpenArchitect login: root
   ```

4. You are now logged in and should see the following shell prompt:

   ```
   [ZX6000-OA3.2.2h]#
   ```

NOTE: The OOB port is not active by default with the factory configured configuration. The first time you log into the switch either in-band or through the console cable you must use the `ifconfig` command to make the port active.

Connecting to the Fabric Interface

Fabric Interface Serial Port Connection

The switch console can be accessed via one RJ-45 10/100 serial port (3) located on the front panel of the Ethernet Switch Blade. The RS-232 RJ-45 console port may be used to recover from a system failure. It is used for maintenance only and is generally not connected.

An RS-232 to RJ-45 adapter cable is required to connect to the console port of the switch. See the Users Guide for more information.

Figure 10.3 showsthe RJ-45 serial console (3) and Out-of-Band (OOB) ports (4) for the Fabric Interface.

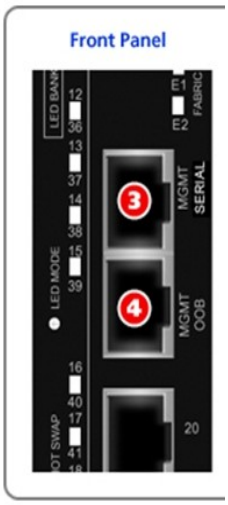


Figure 10.3: Fabric Interface Serial Ports

To attach the console cable to the Ethernet Switch Blade switch:

6. Plug the RJ-45 end of the console cable (P/N 6900-63006, shipped with the HP by5700 ATCA 14-Slot Blade Server) into the RJ-45 Console Port (1) on the front panel.
7. Connect the DB-9 end of console cable into a standard Modem Eliminator Cable (normally locally available).
8. Connect the DB-9 header on the other end of the Modem Eliminator Cable to a standard COM port on your PC or laptop computer (9600, n, 8, 1).

9. Reinsert the switch into the system and power up.
10. Use a terminal emulation program to access the switch console.

Fabric Interface Out of Band Ethernet Connection

Connect an Ethernet cable from the Ethernet Switch Blade front panel MGMT OOB (4 in Figure 10.3) to your PC.

1. Configure a host on the 10.0.0.0 network.
2. The OpenArchitect switch is preconfigured with address 10.0.0.42. `telnet` to 10.0.0.42.

   ```
   telnet 10.0.0.42
   ```

3. After you are connected, enter the login name `root`. No password is required.

   ```
   OpenArchitect login: root
   ```

4. You are now logged in and should see the following shell prompt:

   ```
   [Ethernet Switch Blade-OA3.2.2h]#
   ```

NOTE: The OOB port is not active by default with the factory configured configuration. The first time you log into the switch, either in-band or through the console cable, you must use the `ifconfig` command to make the port active.

Chapter 11 Diagnosing a Failed Ethernet Switch Blade Activation

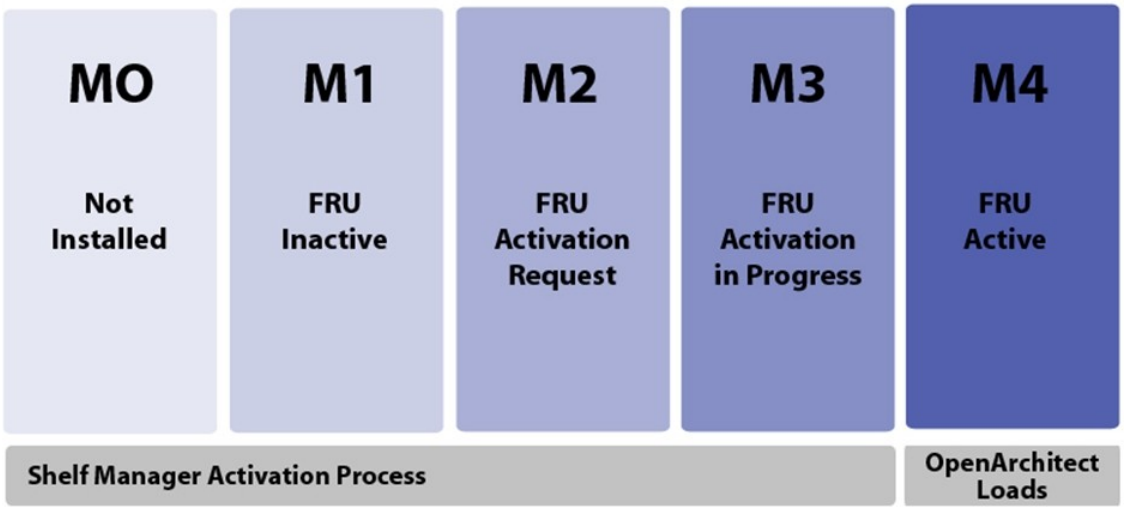


Figure 11.1: Ethernet Switch Blade Activation States

The Ethernet Switch Blade must transition through a series of states (M0–M4) to become active in an ATCA shelf. After the Ethernet Switch Blade has reached the M4 state, it will become active and start the boot process of the OpenArchitect Switch Management environment. If a failure occurs during the Shelf Manager activation stage, the Ethernet Switch Blade has to be diagnosed through the ShMM as the OpenArchitect environment is not booted.

Table 11.1 lists the solutions to problems that may occur at the different stages the Ethernet Switch Blade transitions through to become active and steps that should be taken if it fails during activation.

FRU State	HotSwap LED Status	Healthy LED Status	Solution
M0	OFF	OFF	No power. Board not inserted correctly. 1. Remove and re-insert board. 2. If board does not power-up after re-insertion, try a different slot. If board continues to fail in the new slot and the problem does not affect other boards running in the chassis, return the Ethernet Switch Blade board for repair.
M1	ON	ON	No Communication with the Shelf Manager. Make sure the hot swap ejector handle is securely closed. The Hot Swap LED may remain lit or blinking if awaiting permission to activate from the ShMM If the Hot Swap handle is closed, retrieve the Mstate information from the ShMM. Use the tips in the Accessing the ShMM section below to determine if other FRUs are also encountering difficulty (could indicate a chassis-wide failure of the IPMB bus)
M2	LONG BLINK	OFF	If the switch has reported critical sensor data for temperature or voltage, the ShMM can prevent the switch from booting. To determine if the critical sensor events persist, it may be necessary to alter the rules enforced by the ShMM to allow the switch to boot (receive back-end power). See Accessing the ShMM section, below, for more information
M3	OFF	OFF	Check the Shelf Managers to see if the voltage and temperature sensors are within threshold (see the Accessing the ShMM section below for how to retrieve these values or detect critical thresholds exceeded events), this indicates an internal hardware fault and inoperable IPMC. Replace the switch. Follow the other troubleshooting tips in the Accessing the ShMM section below to determine if exceeded thresholds are specific to the switch, or might indicate a chassis-level problem (if other FRUs are also reporting similar events).
M4	OFF	ON	Switch Operational State. Try connecting into the

FRU State	HotSwap LED Status	Healthy LED Status	Solution
			switch through a console cable. If OpenArchitect is running, and abnormal behavior is occurring, please see Network Configuration Problems for information on network issues. If OpenArchitect cannot be accessed through the console port, please see Troubleshooting a Failed OpenArchitect Load.

Table 11.1: Troubleshooting States

Accessing the ShMM

If the Ethernet Switch Blade has not successfully booted, it will not be accessible via a remote connection. Some of the following procedures will require local access to the switch to examine the hardware, and possibly a locally attached serial console connection.

Access to the ShMM (either via a remote telnet session or a local console) will also be used to gather some additional information about the state of the switch and other FRUs in the chassis. If a remote connection to the ShMM can be established, it is possible to collect some preliminary troubleshooting data.

Consult your Chassis user's guide for more information on logging into the Shelf Manager, and see *Verifying Communications Between the ShMM and Switch*, below.

Verifying Communications Between the ShMM and Switch

Verify that the communications between the IPMC on the switch and the ShMM have been established. Try to see if the switch will respond to the following command requests:

```
GetSensorReading

GedDevID
```

If the ShMM cannot communicate with the Ethernet Switch Blade, check other devices in the chassis. if the Ethernet Switch Blade is the only device not responding, replace the switch.

If the ShMM can communicate with the Ethernet Switch Blade, see the *Critical Threshold Error Reported* section, below.

Critical Threshold Error Reported

The ShMM may have been configured to remove back-end power from a FRU reporting critical

sensor information. Examine the System Event Log (SEL) on the ShMM and determine if critical sensor events have been logged for the switch in question.

If the switch has reported critical sensor data for temperature or voltage, the ShMM can prevent it from booting. To determine if the critical sensor events persist, it may be necessary to alter the rules enforced by the ShMM to allow the switch to receive back-end power and boot (see the ShMM documentation for instruction).

If other FRUs, in addition to the failed switch, are reporting similar critical sensors, such as temperature or voltage, this may indicate a chassis-related failure (such as fans or power supply).

Voltage: If the Ethernet Switch Blade continues to report voltage critical threshold error after changing the rules in the ShMM to allow it to receive power, then return the switch for repair.

Temperature: If the Ethernet Switch Blade continues to report a temperature critical temperature error after changing the rules, check the fans to make sure that there is sufficient airflow to the switch. If airflow is sufficient, and the temperature threshold is still reported, then return the switch for repair.

Analyzing Mstate information for the switch

The SEL will also contain Mstate information for the switch that can be useful in determining conditions related to a failed boot. Knowing the state change transition history in the SEL can help to narrow down activation problems with the switch. The states are defined as follows:

M0 – No power and hot swap handle open

M1 – No communications. Wait in M1 until hot swap ejector is closed.

M2 – FRU announces its presence to the ShMM and awaits activation permission

M3 – Activation

M4 - Operational state; command issued to enable back-end power.

M5 – Deactivation request, such as hotswap ejector opened

M6 – Deactivation granted by ShMM

M7 – Unexpected loss of communication between FRU and ShMM

The information in the SEL will mostly reflect problems that can be related to the IPMC functions of the switch. Other problems related to loading the switch software environment during boot might require further analysis of the switch itself.

Checking the ekey Status From the Shelf Manager

You can check the ekey status from the shelf manager with the `clia board <x>` command.

Shelf Manager commands:

```
clia board -v 7
```

or

```
clia board -v 8
```

These commands generate an output that reports if the ShMM thinks it has granted access to ports on the switches. Check the Shelf Manager User's Guide for the expected output.

Chapter 12 Troubleshooting a Failed OpenArchitect Load

The OpenArchitect operating system is loaded from the FlashROM memory into RAM when the Ethernet Switch Blade is activated by the Shelf Manager. If there is a problem with the loading of OpenArchitect due to a hardware failure or corrupt file system, the back-up image can help to troubleshoot the condition. The following chapter provides tips to troubleshooting a failed OpenArchitect load.

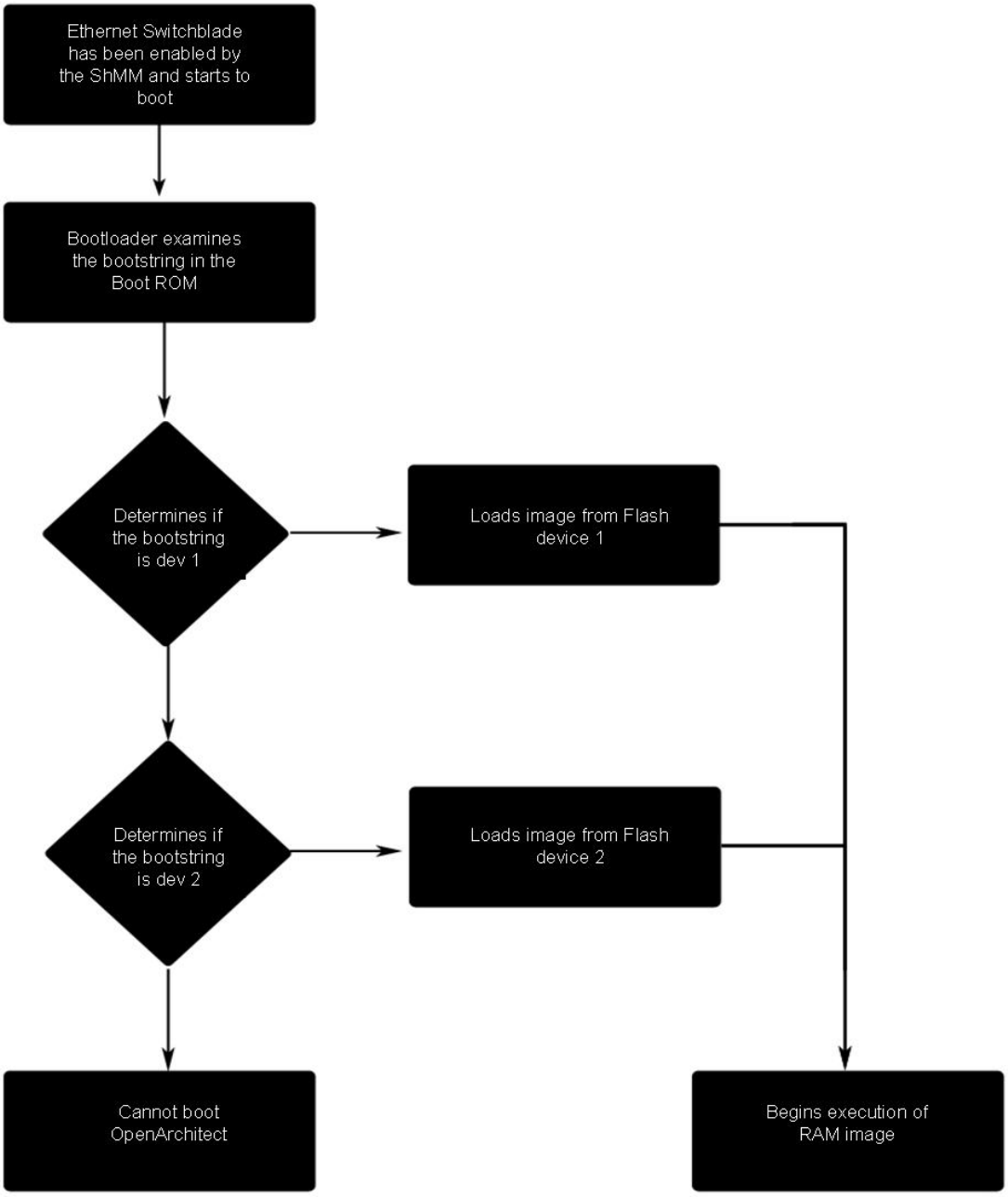


Figure 12.1: OpenArchitect Boot Process

The Ethernet Switch Blade is equipped with a Random Access Memory (RAM) disk and three Read-Only Memory (ROM) devices, including, a boot ROM and two application flash

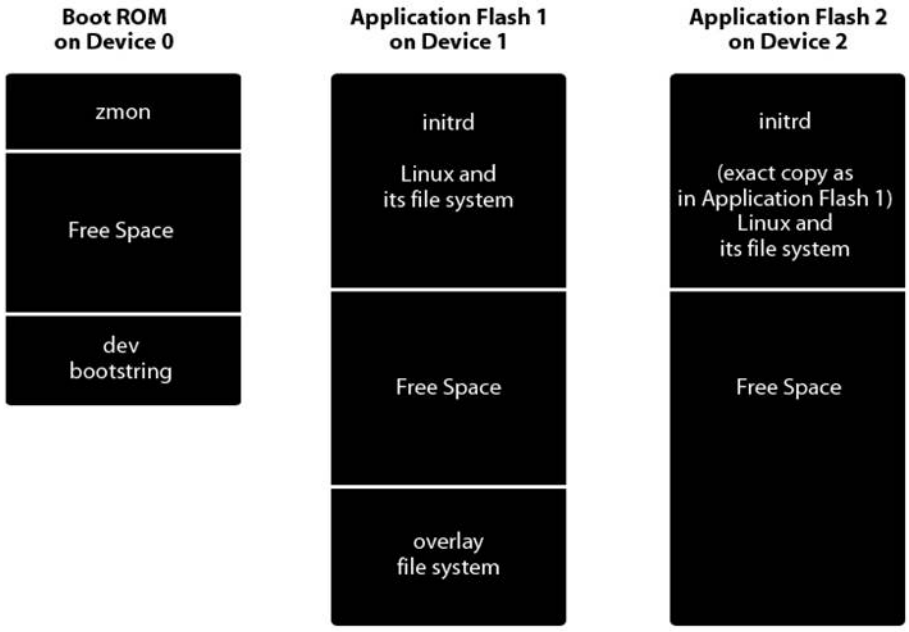


Figure 12.2: ROM Devices in OpenArchitect

The boot ROM is located on device 0 and contains the OpenArchitect `zmon` application that operates as a boot loader and includes a device bootstring. Device 1 contains the application flash 1 image of the Linux operating system and the OpenArchitect overlay file system. Application flash 1 is the primary working image for the switch. Device 2 contains the application flash 2 that is an exact copy of application flash 1. You would only boot from this device if application flash 1 is corrupted and you need to restore the switch to the factory shipped configuration.

Recovering from a System Failure

If the switch does not function after you initially change or reconfigure the image, you have several options for recovering from an error. First, try to `telnet` into the switch. If you are successful, remember to run `zsync` after fixing the problem.

After attaching the system console cable, if the system boots, fix the problem that does not allow you to telnet to the box, run `zsync`, and reboot. The problem is likely to be in the configuration files contained in `/etc/rcZ.`. In order to telnet into the box, there must be a configured interface with a proper IP address. For example, `zhp0` is configured with the IP address 10.0.0.42 in the factory default configuration.

If you cannot `telnet`, attach a console cable and Modem Eliminator Cable to the switch. A console cable (PN A6900-63006) is included with each HP bh5700 ATCA 14-Slot Blade Server, and a Modem Eliminator Cable should be obtainable locally. You can also obtain the correct console cable from your Hewlett-Packard sales representative. Bring down the system and

properly attach the console cable.

Booting Without the Overlay File

If you cannot `telnet` into the switch and Linux fails to boot, it is likely that a change saved by `zsync` has left the switch in an inaccessible state. To allow users to recover from mistakes saved in the overlay file system, a boot argument of `–i` passed to the `init` process will stop the untarring of the saved overlay files. As a result, the system boots to the factory-shipped configuration.

1. Connect through the console port. During boot up, the system displays the Linux boot string. Linux/PPC load: for 5 seconds. During the 5 second pause, enter the boot option `-i` and press Return

   ```
   Linux/PPC load: root=/dev/ram init=/sbin/init -i
   ```

2. Initiating the `–i` option of `zbootcfg`.

   ```
   zbootcfg –d 1 –i
   ```

3. Reboot the system. After the reboot, clear the `–i` option from the boot string. Enter the following command:

   ```
   zbootcfg –d 1
   ```

4. The reboot command will also take `-i` as an option and pass it to the Linux boot,

   ```
   reboot -i
   ```

5. When the system boots, the overlay file system is returned to the factory-installed configuration. At this point, you have a few options.

   Caution: All changes you have made and saved prior to the `zsync` command will be lost when the command executes.

   a) Enter `zsync,` and the factory-installed system will be restored to your flash.

   b) Restore particular files from the existing overlay. Use the `zmnt` command to mount the overlay in a designated directory and copy back just the changes you want to keep from the existing overlay.

      For example, if you wanted to recover your `/etc/hosts` file from the existing overlay, use `zmnt` to mount the overlay in a designated directory, like `/tmp`, then copy /`tmp/etc/hosts` to `/etc/hosts`. Lastly, use `zsync` to save your changes (as follows).

      ```
      zmnt /tmp
      cp /tmp/etc/hosts /etc/hosts
      zsync /etc/hosts
      ```

6. Reboot the system.

If the switch still is unable to boot, see *Booting the Duplicate Flash Image*, below.

Booting the Duplicate Flash Image

Another recovery method, if Linux fails to boot, is to temporarily boot the factory-installed duplicate image located in the second flash device.

1. Connect through the console port.
2. When you see the number counter appear after the `zmonitor` ... banner, press any key on the console keyboard to enter the `zmon` application.
3. At the monitor prompt, type: boot:2
4. You should see the counter again, but the system should boot into the secondary kernel. If you have difficulties booting, contact Hewlett-Packard technical support.
5. At this point, follow the Upgrading the OpenArchitect Image section to put a new RAM disk image in the application flash 1.

   IMORTANT: Do not program flash 2, since this is currently your only bootable image. The command to program flash 1 should be similar to the following command. The image name may be slightly different depending on the model of switch and version of the image.

   Base Interface: `zflash -d 1 rdr6000.zImage.initrd`

   Fabric Interface: `zflash –d 1 rdr7100.zImage.initrd`

   NOTE: If the duplicate flash image cannot be loaded, remove and return switch for repair.

Chapter 13 Network Configuration Problems

Many reported problems on a booted switch will ultimately be traced back to user errors in the layer 2 or layer 3 switch configuration. In some cases, symptoms from an improperly configured switch can masquerade as potential hardware problems.

Interface Overview

On startup OpenArchitect creates interfaces for all Ethernet ports on the Ethernet Switch Blade. The three types of interfaces within the OpenArchitect environment are:

- **zhp** - Host Port: A `zhp` interface is associated with one VLAN (Virtual Local Area Network). `zhp`s can contain one or more physical interfaces (`zres`*)* to create a private network that does not let traffic cross interfaces outside of the VLAN.
- **zre** - Raw Ethernet: An interface that represents a physical port on the OpenArchitect switch.
- ***z*rl** – Trunk of Ports (Link Aggregation)
- **eth** - Each switch, fabric and base, in a Ethernet Switch Blade Series unit has Out-of-Band (OOB) Ethernet port on the front panel. These are an alternative maintenance port supplying Ethernet connectivity instead of serial connectivity and are connected only when performing switch maintenance activities.

Physical Interfaces

The tables below provides a translation guide for mapping the `zre` ports to the termination point. Table 13.1 details the `zre` interface to the slot in the backplane that it terminates. Table 13.2 lists all other Ethernet Switch Blade interfaces including management, and egress ports.

Table 13.1: Ethernet Switch Blade Backplane Interfaces (`zre` Ports)

Physical Slot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Base	20	10	8	6	4	3	23*		0	1	3	5	7	9	11	21
Fabric Port 0	40	36	32	28	16	8	-	-	0	4	12	24	30	34	38	42
Fabric Port 1	41	37	33	29	17	9	-	-	1	5	13	25	31	35	49	43
Fabric Port 2					18	10	-	-	2	6	14	26				

Physical Slot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Fabric Port 3					19	11	-	-	3	7	15	27				
Fabric							51**									

* Base Interface Inter-Switch Link (ISL)

** 10 Gigabit Ethernet Fabric Interface - Update Channel

Table 13.2: Additional Interfaces

Additional Interfaces	Base	Fabric
Front Panel Egress (zre)	12	20
	-	21
	14	22
	15	23
Shelf Manager 1 (zre)	22	-
Shelf Manager 2 (zre)	13	-
Front Panel Out-of-Band Management Port (eth)	0	0

NOTE: The Out-of-Band (`eth`) ports are not enabled by default. Edit the `S50layer2` script or `ifconfig eth0` for front panel access or `eth1` for rear panel access (not implemented this release) on either the Base or Fabric Interfaces.

Default Base Interface Configuration

Editing the `S50layer2` script can change the Ethernet Switch Blade Base Interface default configuration. The `S50Layer2` script and included example scripts (`/etc/rcZ.d/examples`) can be used as templates to create custom scripts. The default `S50layer2` scripts configures the switch accordingly:

24 port, Layer 2 Switching, single VLAN

1. `S20stack` - Script that calls `zstack` to combine the two BCM5695 twelve-port switch fabric chips into a single 24 port virtual switch. `zstack` must be run before any other switch configuration. (**Editing this script is not recommended.**)

2. `S30e1000` - Script that loads the e1000 driver module for the Out-of-Band Ethernet ports. **(Editing this script is not recommended.)**

   `S40vpd` - Script that checks the current OA version, and loads into the Vital Product Data (VPD) area if necessary. **(Editing this script is not recommended.)**

3. `S50layer2` - Script that sets up a basic Layer 2 switch. All 24 10/100/1000 ports are set up on one IP network (VLAN).

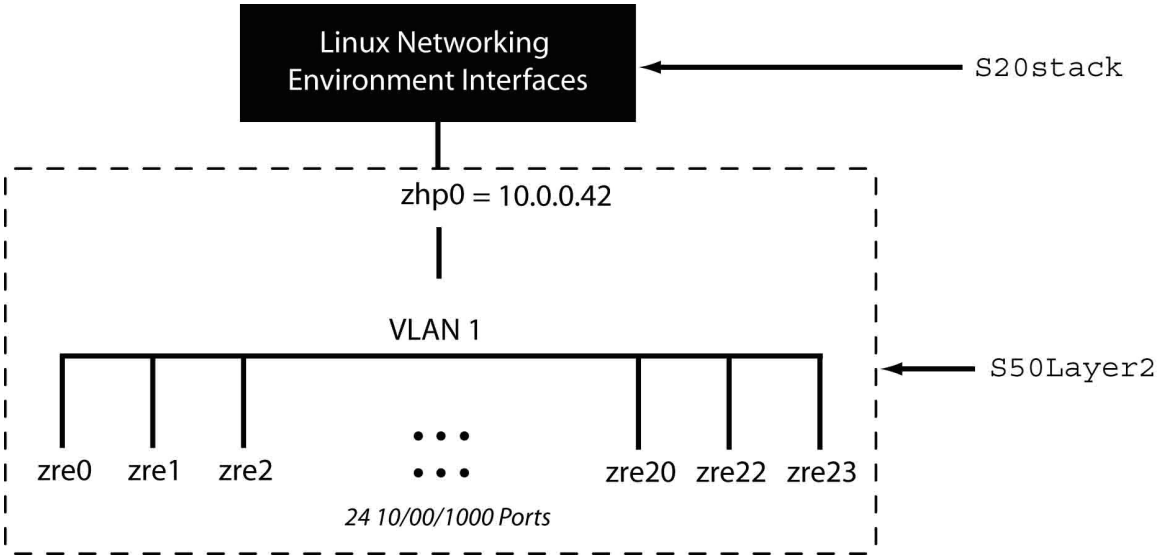


Figure 13.1: Default Base Interface Network Diagram

```
OpenArchitect login: root
sh-2.04# ifconfig
lo Link encap:Local Loopback
 inet addr:127.0.0.1 Mask:255.0.0.0
 UP LOOPBACK RUNNING MTU:16144 Metric:1
 RX packets:0 errors:0 dropped:0 overruns:0 frame:0
 TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
 collisions:0 txqueuelen:0
 RX bytes:0 (0.0 b) TX bytes:0 (0.0 b)

zhp0 Link encap:Ethernet HWaddr 00:11:65:09:E0:18
 inet addr:10.0.0.42 Bcast:10.0.0.255 Mask:255.255.255.0
 UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
 RX packets:281 errors:0 dropped:0 overruns:0 frame:0
 TX packets:29 errors:0 dropped:0 overruns:0 carrier:0
 collisions:0 txqueuelen:100
 RX bytes:30018 (29.3 Kb) TX bytes:2027 (1.9 Kb)
 Base address:0xc000

sh-2.04#
```

Default Fabric Interface Configuration

Editing the `S50layer2` script can change the Ethernet Switch Blade Fabric Interface default configuration. The `S50Layer2` script and included example scripts (`/etc/rcZ.d/examples`) can be used as templates to create custom scripts. The default `S50layer2` script configures the switch accordingly:

1. `S20stack` - Script that calls `zstack` to combine the two BCM56504 24-port switch fabric chips into a single 48 port virtual switch. `zstack` must be run before any other switch configuration. (E**diting this script is not recommended.**)

2. `S50layer2` - Script that sets up a basic Layer 2 switch. All 48 ports are set up on one VLAN. This configuration script is appropriate for an Ethernet Switch Blade. It may need to be modified for other models.

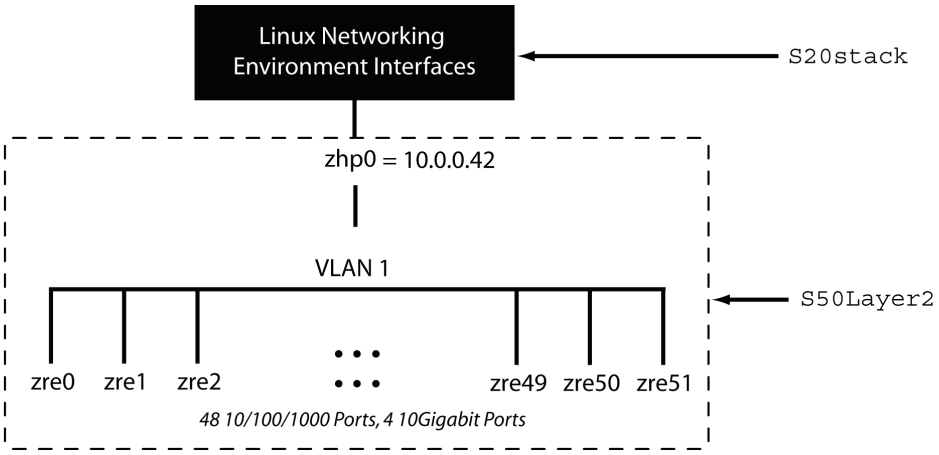


Figure 13.2: Linux Networking Environment Interfaces

ifconfig Default Screen Output for the Base Interface

```
[ZX7100-OA3.2.2h]# ifconfig
lo Link encap:Local Loopback
 inet addr:127.0.0.1 Mask:255.0.0.0
 UP LOOPBACK RUNNING MTU:16144 Metric:1
 RX packets:0 errors:0 dropped:0 overruns:0 frame:0
 TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
 collisions:0 txqueuelen:0
 RX bytes:0 (0.0 b) TX bytes:0 (0.0 b)

zhp0 Link encap:Ethernet HWaddr 00:11:65:0B:C0:38
 inet addr:10.0.0.42 Bcast:10.0.0.255 Mask:255.255.255.0
 UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
 RX packets:488 errors:0 dropped:0 overruns:0 frame:0
 TX packets:377 errors:0 dropped:0 overruns:0 carrier:0
 collisions:0 txqueuelen:100
 RX bytes:32716 (31.9 Kb) TX bytes:92079 (89.9 Kb)
 Base address:0x5000
[ZX7100-OA3.2.2h]#
```

Configuration Troubleshooting

Problem	Solution
No Connection	Physical Link problem. Check to see if the port LED is lit. If the LED port is not lit, then you may have a bad cable connection. OR Configuration Error. Connect through the console port (See Chapter 10). Use the `ifconfig` command to see all of the configured interfaces on the Ethernet Switch Blade and their IP addresses. Check to make sure that the IP address of the switch and the subnet mask are properly set. Also, the section on *No Connection* for more information.
Decreased throughput	You should make sure that your network topology contains no data path loops. Between any two end nodes, there should be only one active cabling path at any time. Data path loops will cause broadcast storms that will severely impact your network performance. See the section on *Diminished Network Throughput*.
High Error Rates, Decreased Throughput	If the interfaces on the Ethernet Switch Blade and the node board are not set to auto by default, the link may not negotiate correctly. See the section on *Connecting to Devices with Fixed Port Speeds*.
Ext FLT LED on	The EXT FLT LED indicates that communications could not be established with one or more remote partner devices on an active port or ports. Ports which were configured to be up (via `ifconfig`), but do not have remote partner devices attached, can cause the EXT FLT LED to be lit, even if there are no hardware problems with the switch. See the *Network Configuration Problems* chapter for more information
Ekey Disabled	By default, if there is no device plugged into a node slot in the ATCA chassis, the Shelf Manager will `ekey` disable the port. If a node board is inserted and the ports on the Ethernet Switch Blade are still `ekey` disabled by the Shelf Manager, check to see if the node board has been properly activated by the Shelf Manager.

Determining ekey status for a specific slot

You can determine the current state of any link by using the `zlc` command. The `zlc` command will output the current status of any/all Ethernet ports and their `ekey` status that was set by the Shelf Manager.

The following table will translate the `zlc` output to link status.

Link	Port Status	Link Speed	Pause	Faults	OK
Zre (x)	EKEY_DISABLED	Auto	Enable	Internal Fault	ON
	EKEY_ENABLED	1000fd	Disable	External Fault	
	UP	1000hd			
	DOWN	100fd			
		100hd			
		10fd			
		10hd			

Link: `zre(X)` – physical interface

Shelf Manager Status: **EKEY_DISABLED -** A slot or device that has been disabled by the Shelf Manager.

EKEY_ENABLED - A slot or device that has been enabled by the shelf manager and enabled by the Ethernet Switch Blade switch.

UP – The port has been configured to be active and has established a link with another network device.

DOWN – The port has been configured to be active but has not establish a link with another network device.

Link Speed: **Auto** – Auto Negotiate with the other device. The node device must be configured to Auto Negotiate as well or network connectivity errors will occur.

1000fd – Full Duplex Gigabit Ethernet

1000hd – Half Duplex Gigabit Ethernet

100fd – Fast Ethernet Full Duplex

100hd – Fast Ethernet Half Duplex

10fd – Ethernet Full Duplex

10hd – Ethernet Half Duplex

Pause: **Enable:** a port that can temporarily suspend the data transmission between two network devices in the event that one of the devices becomes congested. Pause enabled devices can reduce bottlenecks by making the network more efficient.

Disabled: The pause feature is not enabled and will continue to transmit traffic when even when the receiving device is busy.

Faults: **Internal:** An internal fault indicates a severe hardware failure

External: An external fault indicates that a port has been configured to active, but a link has not been established.

OK: **ON:** Indicates that the Ethernet Switch Blade has successfully loaded OpenArchitect.

Querying Base Interface ekey Status

Link Status for a single port

To query a link status for a single port type `zre<x> query` for example:

```
zlc zre13 query
```

Example Output:

```
sh-2.04# zlc 13 query
zre13: <UP, 100FD, PAUSE ENABLE OFF, OK ON>
sh-2.04#
```

Link Status for a range of ports

To query the link status for a range of ports type `zre<x>..<x> query` for example:

```
zlc zre0..23 query
```

Example Output:

```
sh-2.04# zlc zre0..23 query
zre0: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre1: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre2: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre3: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre4: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre5: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre6: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre7: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre8: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre9: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre10: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre11: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre12: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre13: <UP, 100FD, PAUSE ENABLE OFF, OK ON>
zre14: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre15: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre16: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre17: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre18: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre19: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre20: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre21: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre22: <UP, 100FD, PAUSE ENABLE OFF, OK ON>
zre23: <UP, 1000FD, PAUSE ENABLE ON, OK ON>
sh-2.04#
```

NOTE: this is the `zlc` output for a single Ethernet Switch Blade Base Interface in the default configuration with no line cards installed in the chassis.

Querying Fabric Interface ekey Status

Link Status for a single port

To query a link status for a single port type `zre<x> query.` For example:

```
zlc zre13 query
```

Example Output:

```
[ZX7100-OA3.2.2h]# zlc zre13 query
zre13: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
[ZX7100-OA3.2.2h]#
```

Link Status for a Range of Ports

To query the link status for a range of ports type `zre<x>..<x> query.` For example:

```
zlc zre0..51 query
```

Example Output:

```
[ZX7100-OA3.2.2h]# zlc zre0..51 query
zre0: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre1: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre2: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre3: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre4: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre5: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre6: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre7: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre8: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre9: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre10: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre11: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre12: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre13: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre14: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre15: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre16: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre17: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre18: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre19: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre20: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre21: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre22: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre23: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre24: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre25: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre26: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre27: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre28: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre29: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre30: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre31: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre32: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre33: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre34: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre35: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre36: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre37: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre38: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre39: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre40: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre41: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre42: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre43: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre44: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre45: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre46: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre47: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre48: <STOPPED, 10GFD, PAUSE ENABLE, EXT_FLT ON, INT_FLT ON, OK ON>
zre49: <STOPPED, 10GFD, PAUSE ENABLE, EXT_FLT ON, INT_FLT ON, OK ON>
zre50: <STOPPED, 10GFD, PAUSE ENABLE, EXT_FLT ON, INT_FLT ON, OK ON>
zre51: <DOWN, 10GFD, PAUSE ENABLE, EXT_FLT ON, OK ON>
[ZX7100-OA3.2.2h]#
```

Network Connectivity Troubleshooting

No Connection

If the port LED is lit on the front panel, the switch has established a physical connection and the problem is a network configuration error. Check to see if both devices are configured to be on the same network (ex. 10.0.0.xxx) and that the subnet mask is set correctly.

Diminished Network Throughput

Depending on how the switch is configured, throughput problems can reflect configuration errors in the network topology.

If the Spanning Tree Protocol (STP) is not enabled, it is possible for broadcast loops to occur which can stress the network. The `tcpdump` (See the *Ethernet Switch Blade User's Guide* for more information) utility is a widely used network troubleshooting tool which can display network traffic according to user-defined filters, which can help to troubleshoot problems such as broadcast loops. The `tcpdump` utility is included with the switch's OA environment.

If STP is enabled, be sure to identify ports which were automatically blocked by the STP daemon to prevent broadcast loops.

A network diagram can be useful in isolating network loops.

Connecting to Devices with Fixed Port Speeds

Verify that switch and the connected devices are set to the same port speed setting, otherwise diminished or no connections can be made. If devices connected to the Ethernet Switch Blade are connected at a fixed Full Duplex, high error rates or sporadic connectivity can be observed. It is recommended that all devices connected to the Ethernet Switch Blade be set to auto-negotiate.

External Fault LED

The EXT FLT LED indicates that communications could not be established with one or more remote partner devices on an active port or ports. Ports which were configured to be up (via `ifconfig`), but do not have remote partner devices attached, can cause the EXT FLT LED to be lit, even if there are no hardware problems with the switch.

The `OA zlc` command can be used to check the status of individual ports and also to manipulate how the EXT FLT LED is managed (globally or on a per-port basis). By default, the EXT FLT LED is a global indicator. Use the `zlc` command to change how the LED is managed, to help isolate external fault indications to a particular port.

Before acting on an EXT FLT LED indication, make sure the configuration for the switch reflects how the chassis is populated with expected device configurations. For example, if a "default" configuration was used on the switch to bring up all ports on startup, but not all of those ports

have an active remote device attached, then first bring down the ports which do not have active connections expected to make sure there is a legitimate EXT FLT condition.

If loss of communications is suspected on an externally wired port, make sure to check and test affected cables.

Network Tests

Ping Test

It is possible to test a network connection by using the `ping` command. The `ping` command will send a network packet to the specified IP address and wait for a reply.

To initiate a ping test, type

```
ping <ip address>
```

If you have a network connection, a normal output would look like the following:

```
sh-2.04# ping 10.0.0.43
PING (10.0.0.43): 56 data bytes
64 bytes from 10.0.0.43: icmp_seq=0 ttl=109 time=69.094 ms
64 bytes from 10.0.0.43: icmp_seq=1 ttl=109 time=69.341 ms
64 bytes from 10.0.0.43: icmp_seq=2 ttl=109 time=69.363 ms
64 bytes from 10.0.0.43: icmp_seq=3 ttl=109 time=69.109 ms
64 bytes from 10.0.0.43: icmp_seq=4 ttl=109 time=69.859 ms
64 bytes from 10.0.0.43: icmp_seq=5 ttl=109 time=68.865 ms
64 bytes from 10.0.0.43: icmp_seq=6 ttl=109 time=69.180 ms
64 bytes from 10.0.0.43: icmp_seq=7 ttl=109 time=69.496 ms
64 bytes from 10.0.0.43: icmp_seq=8 ttl=109 time=69.373 ms
64 bytes from 10.0.0.43: icmp_seq=9 ttl=109 time=70.680 ms

10 packets transmitted, 10 packets received, 0% packet loss
round-trip min/avg/max/stddev = 68.865/69.436/70.680/0.486 ms
sh-2.04#
```

results:

```
sh-2.04# ping 10.0.0.43
ping: cannot resolve 10.0.0.43: Unknown host
sh-2.04#
```

Traceroute Test

It's possible to trace a network path using the `traceroute` command. The following is an example of a Layer 2 `traceroute` with only two devices.

```
sh-2.04# traceroute 192.168.1.101
traceroute to 192.168.1.101 (192.168.1.101), 64 hops max, 40 byte
packets 1 192.168.1.101 (192.168.1.101) 1.888 ms 1.135 ms 0.814 ms
sh-2.04#
```

Chapter 14 Isolating Hardware Failures

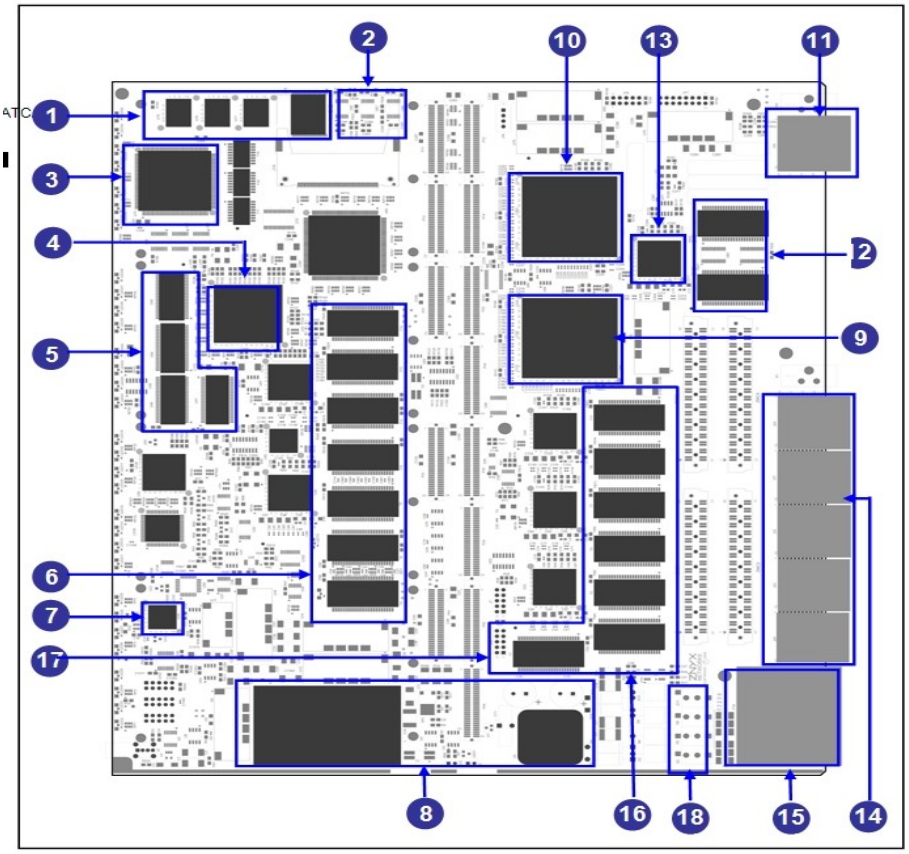


Figure 14.1: ATCA Base Inside View

1.	Flash	10.	Switch Chip (U69)
2.	EEPROM	11.	Zone 3 ATCA Connector
3.	PHY	12.	Isolation Transformers
4.	CPU	13.	4-port PHY
5.	SDRAM	14.	Zone 2 ATCA Connector
6.	Isolation Transformer	15.	Zone 1 ATCA Connector
7.	IPMI Controller	16.	Isolation Transformers
8.	Power Supply	17.	4 port PHY
9.	Switch Chip (U56)	18.	Fuses

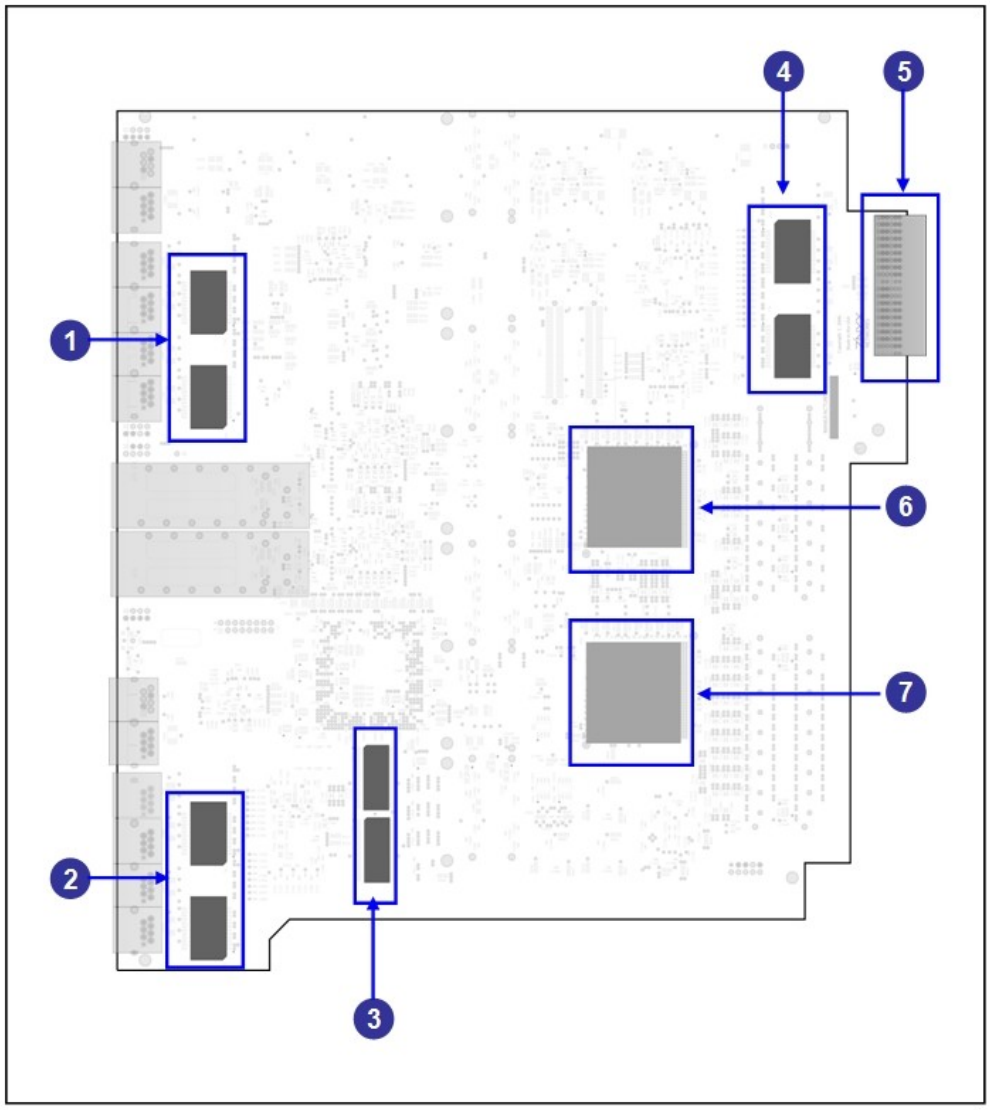


Figure 14.2: ZMC Daughter Card Outside View

1.	Isolation Transformer	2.	Zone 3 ATCA Connector
3.	Isolation Transformer	4.	Switch Chip (U60)
5.	SDRAM	6.	Switch Chip (U59)
7.	Isolation Transformer		

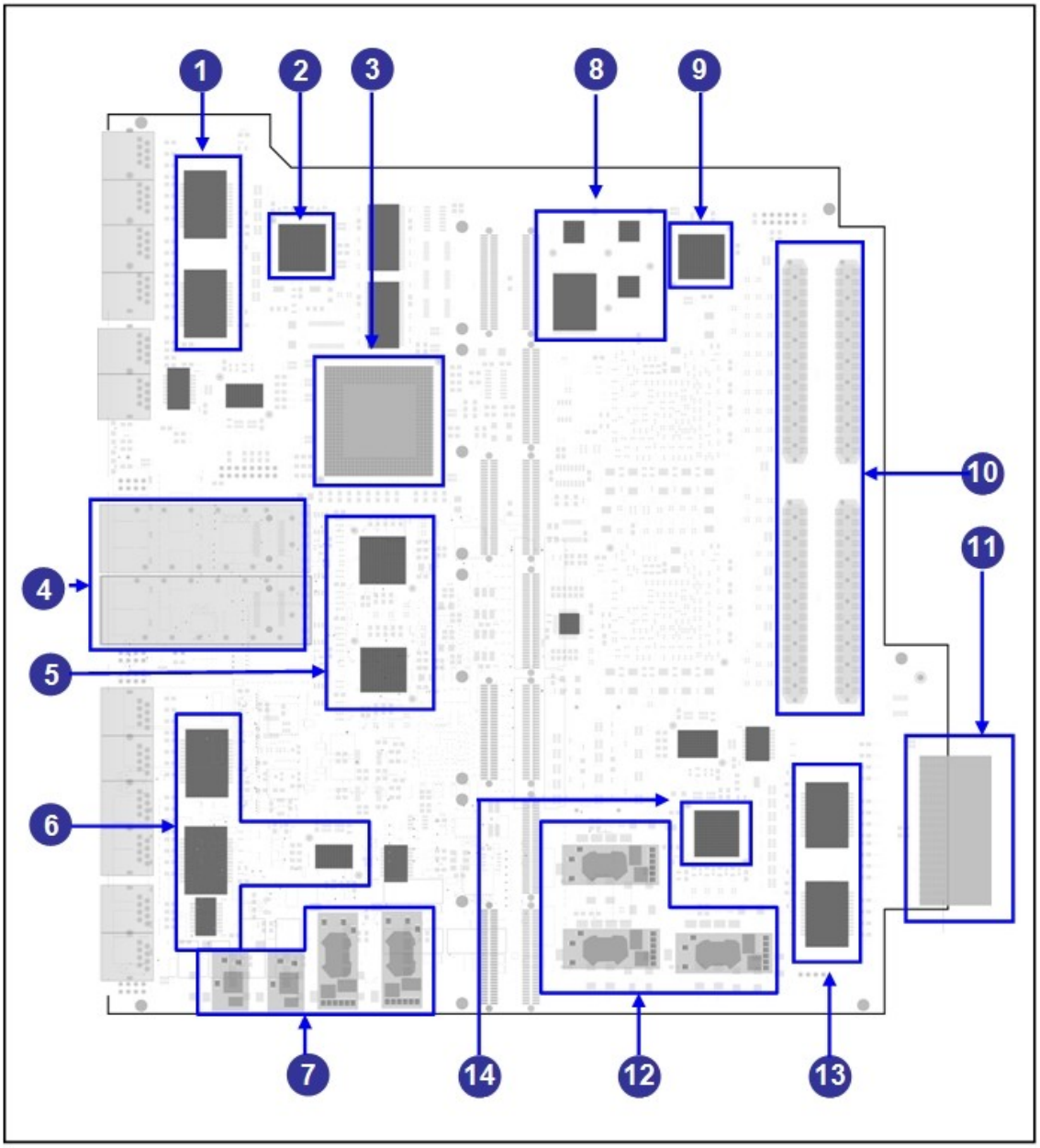


Figure 14.3: ZMC Daughter Board Inside View

1.	Isolation Transformer	8.	Flash ROMs
2.	4 Port PHY	9.	FPGA
3.	CPU (U22)	10.	ZMC Connector
4.	10 Gigabit XFP	11.	Zone 3 ATCA Connector
5.	10 Gigabit PHY	12.	Power Supply

6.	Isolation Transformer	13.	Isolation Transformers
7.	Power Supply	14.	4 Port PHY

Hardware Subsystem

In the following tables, refer to the identified component-area numbers on indicated in the pictures in the proceeding section. The indications of malfunction may be identified either during normal operation, or in response to a specific test. The various tests that may be initiated are shown in subsequent sections.

The information is equally applicable to both the Base Interface and the Fabric Interface switch subsystems unless otherwise noted.

Base	ZMC 0 #	ZMC 1 #	Hardware Subsystem	Indications of Malfunction
4	3		CPU	A CPU failure may be indicated by any of the following: • A failure to run the Power-On-Self-Test (POST) • A failure to boot the OpenArchitect kernel • Kernel panics Loss of CPU response sometime after operation is initiated
5		3	RAM	The Ethernet Switch Blade uses SDRAM for the primary CPU memory system. A failure of RAM will generally cause any of the following: • Kernel panics • Loss of CPU response • Unexplained software failures
1	8		ROM	The Flash ROM subsystem on the Ethernet Switch Blade is used only on boot-up. The contents are decompressed and copied to RAM memory for further use. A ROM failure will generally cause a failure in the boot process.
9, 10		6, 7	Switch Fabric	The Ethernet Switch Blade has four switch fabric chips: 2 for the Base Interface with 24 ports, and 2 for the Fabric Interface with 48 ports. A Switch Fabric failure may result in

Base	ZMC 0 #	ZMC 1 #	Hardware Subsystem	Indications of Malfunction
				any of the following indications: • Error message via OpenArchitect due to inability to access the registers within the switch chip, or a failure of DMA transfers. • Loss of switch functionality, such as the inability to forward packets, or forwarding packets in error.
8	12		Power Supply	A power-supply failure will generally result in lack of boot activity.
3, 6, 12, 13, 16, 17	2, 4, 6, 13, 15	1, 2, 4	Ethernet PHYs & Transformers	An error in the PHY will generally result in loss of link, or Ethernet data transfer errors such as Checksum and Frame Alignment. Note that for ATCA 3.1 Fabric ports, there is no separate PHY devices or transformers; the `SerDes` interface in the switch chips are used instead.
	9		FPGA	Most FPGA failures will result in the CPU failing the boot process.
			BOOT ROM	If the Boot ROM fails or is not programmed, there will be no boot activity on the console port after power up.
			Network Cable	Network cable failures will result in loss of link or loss of data packets.
7			IPMI Controller	If the IPMI controller is not functioning, the Ethernet Switch Blade board will not power up when inserted into a powered-up chassis. This condition may also result from a failure within the ATCA Shelf Manager (ShMM) or if the ShMM determines that the chassis cannot support the Ethernet Switch Blade.

Testing the FlashROMs

The FlashROMs (device 1 and 2) contain compressed images of the OpenArchitect operating system. FlashROM device 1 is the primary operating system image. If OpenArchitect has successfully booted, then FlashROM device 1 is fully operational.

To test FlashROM device 2, set the Ethernet Switch Blade to load the backup image on reboot. For instructions on temporarily booting from FlashROM device 2, see the section on *Booting the*

Duplicate Flash Image. If the switch can successfully boot from FlashROM device 2, then FlashROM device 2 is fully operational.

Testing the Switch Fabric

You can test the functionality of the switch fabric by running the `zlc` command. The `zlc` command outputs the link status for any Ethernet Switch Blade interface.

Link Status for a single port

To query a link status for a single port type `zre<x> query` for example:

```
zlc zre13 query
```

Example Output:

```
sh-2.04# zlc zre13 query
zre13: <UP, 100FD, PAUSE ENABLE OFF, OK ON>
sh-2.04#
```

Link Status for a range of ports

To query the link status for a range of ports, type `zre<x>..<x> query.` For example:

```
zlc zre0..23 query
```

Example Output:

```
sh-2.04# zlc zre0..23 query
zre0: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre1: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre2: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre3: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre4: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre5: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre6: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre7: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre8: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre9: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre10: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK
ON>
zre11: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK
ON>
zre12: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre13: <UP, 100FD, PAUSE ENABLE OFF, OK ON>
zre14: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre15: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre16: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre17: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre18: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre19: <DOWN, AUTO, PAUSE ENABLE, EXT_FLT ON, OK ON>
zre20: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK
ON>
zre21: <EKEY_DISABLED, AUTO, PAUSE ENABLE, EXT_FLT ON, OK
ON>
zre22: <UP, 100FD, PAUSE ENABLE OFF, OK ON>
zre23: <UP, 1000FD, PAUSE ENABLE ON, OK ON>
sh-2.04#
```

NOTE: This is the `zlc` output for a single Ethernet Switch Blade Base Interface in the default configuration with no line cards installed in the chassis.

Testing the onboard RAM

You can test the onboard memory by running the `free` command. The `free` command will output the current memory usage.

h-2.04#						
	Total	Used	Free	Shared	Buffers	Cached
em:	254716	46816	207900	5088	10000	22664
-/+ buffers/cache:		14152	240564			
wsp:	0	0	0			
h-2.04#						

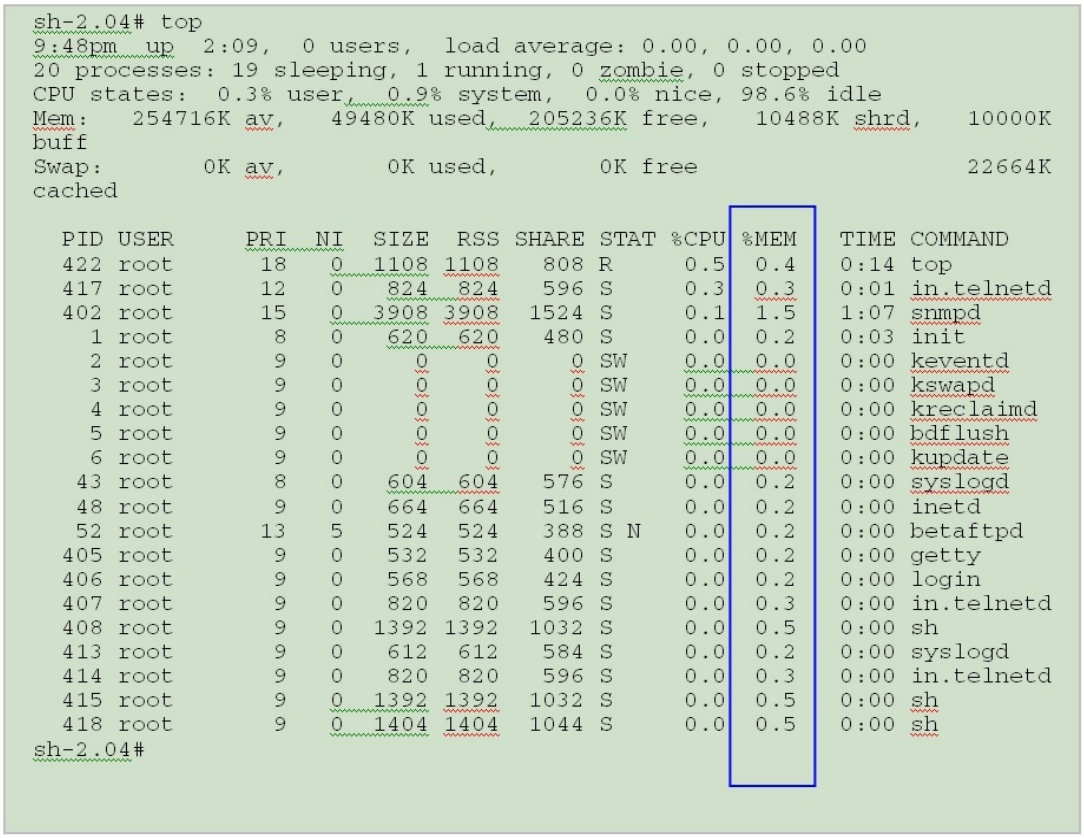
If the “Used” and “Free” memory statistics do not add up to the Total memory, the software environment may have a memory leak caused by a software error. Reboot the switch.

If the problem persists after a reboot. Run the `top` command to list the memory utilization of all current processes.

```
sh-2.04# top
```

The `top` command can help you isolate software related memory problems to specific processes.

Example output:



```
sh-2.04# top
9:48pm  up  2:09,  0 users,  load average: 0.00, 0.00, 0.00
20 processes: 19 sleeping, 1 running, 0 zombie, 0 stopped
CPU states:  0.3% user,  0.9% system,  0.0% nice, 98.6% idle
Mem:   254716K av,   49480K used,  205236K free,   10488K shrd,   10000K
buff
Swap:       0K av,       0K used,       0K free                   22664K
cached

  PID USER     PRI  NI  SIZE  RSS SHARE STAT %CPU %MEM   TIME COMMAND
  422 root      18   0  1108 1108   808 R     0.5  0.4   0:14 top
  417 root      12   0   824  824   596 S     0.3  0.3   0:01 in.telnetd
  402 root      15   0  3908 3908  1524 S     0.1  1.5   1:07 snmpd
    1 root       8   0   620  620   480 S     0.0  0.2   0:03 init
    2 root       9   0     0    0     0 SW    0.0  0.0   0:00 keventd
    3 root       9   0     0    0     0 SW    0.0  0.0   0:00 kswapd
    4 root       9   0     0    0     0 SW    0.0  0.0   0:00 kreclaimd
    5 root       9   0     0    0     0 SW    0.0  0.0   0:00 bdflush
    6 root       9   0     0    0     0 SW    0.0  0.0   0:00 kupdate
   43 root       8   0   604  604   576 S     0.0  0.2   0:00 syslogd
   48 root       9   0   664  664   516 S     0.0  0.2   0:00 inetd
   52 root      13   5   524  524   388 S N   0.0  0.2   0:00 betaftpd
  405 root       9   0   532  532   400 S     0.0  0.2   0:00 getty
  406 root       9   0   568  568   424 S     0.0  0.2   0:00 login
  407 root       9   0   820  820   596 S     0.0  0.3   0:00 in.telnetd
  408 root       9   0  1392 1392  1032 S     0.0  0.5   0:00 sh
  413 root       9   0   612  612   584 S     0.0  0.2   0:00 syslogd
  414 root       9   0   820  820   596 S     0.0  0.3   0:00 in.telnetd
  415 root       9   0  1392 1392  1032 S     0.0  0.5   0:00 sh
  418 root       9   0  1404 1404  1044 S     0.0  0.5   0:00 sh
sh-2.04#
```

Testing the Control Processor

The Base Interface and Fabric Interface control processors are critical components in the operation of the Ethernet Switch Blade. The control processors host the OpenArchitect operating system and manage the switch fabric devices.

To test the operational status of the control processors you can do the following:

Hardware Fault

Connect to the console port of either the Base or Fabric Interface control processor (See Chapter 10 for more information).

If you cannot communicate with the Ethernet Switch Blade, the control processor may have encountered a software error. Reboot the switch to clear the error. If the problem persists, and you are not able to communicate with the Ethernet Switch Blade, replace and return the Ethernet Switch Blade for repair.

Software Error

If you can successfully contact the Ethernet Switch Blade through the console port (See Chapter 10 for more information), enter the `top` command at the command prompt. The `top` command lists the processor utilization of all current processes.

```
sh-2.04# top
```

The `top` command can help you isolate software related problems to specific processes.

Example output:

```
sh-2.04# top
10:58pm  up  3:19,  0 users,  load average: 0.00, 0.00, 0.00
16 processes: 15 sleeping, 1 running, 0 zombie, 0 stopped
CPU states:  0.1% user,  0.7% system,  0.0% nice, 99.0% idle
Mem:   254716K av,   48120K used,  206596K free,    7228K shrd,   10000K
buff
Swap:       0K av,       0K used,       0K free                  22668K
cached

  PID USER     PRI  NI  SIZE  RSS SHARE STAT  %CPU %MEM   TIME COMMAND
  426 root      17   0  1108 1108   808 R     0.5  0.4   0:00 top
  402 root      13   0  3780 3780  1524 S     0.1  1.4   1:43 snmpd
  423 root      10   0   820  820   596 S     0.1  0.3   0:00 in.telnetd
    1 root       8   0   620  620   480 S     0.0  0.2   0:03 init
    2 root       9   0     0    0     0 SW    0.0  0.0   0:00 keventd
    3 root       9   0     0    0     0 SW    0.0  0.0   0:00 kswapd
    4 root       9   0     0    0     0 SW    0.0  0.0   0:00 kreclaimd
    5 root       9   0     0    0     0 SW    0.0  0.0   0:00 bdflush
    6 root       9   0     0    0     0 SW    0.0  0.0   0:00 kupdate
   43 root       8   0   604  604   576 S     0.0  0.2   0:00 syslogd
   48 root       9   0   664  664   516 S     0.0  0.2   0:00 inetd
   52 root      13   5   524  524   388 S N   0.0  0.2   0:00 betaftpd
  405 root       9   0   532  532   400 S     0.0  0.2   0:00 getty
  406 root       9   0   568  568   424 S     0.0  0.2   0:00 login
  413 root       9   0   612  612   584 S     0.0  0.2   0:00 syslogd
  424 root      12   0  1400 1400  1040 S     0.0  0.5   0:00 sh
sh-2.04#
```

6.1.5 INT FLT LED activity

The INT FLT LED indicates that internal communications may have failed on the board. If the

INT FLT LED is illuminated, replace the switch and return it for repair.

Chapter 15 High Availability Troubleshooting

The ATCA environment will usually contain a high-availability failover configuration between two ATCA switches in the chassis. Note that the failover features are configurable and a switch can be directed to fail over all of its processing when a single port or link goes down, or it can perform a port-to-port or VLAN-to-VLAN failover where both partner switches are still processing a portion of the network traffic.

Before replacing a switch that has gone out of service because of a switch-level failover, you need to understand how the high-availability features have been configured. If the switch failover was triggered by a port or link failure, make sure to isolate the cause for the link failure first, to make sure the problem is not external to the switch (for example, a bad or loose cable for a wired port).

Spontaneous Failover Activity

If while rebooting the inactive switch in a chassis causes the active switch to reboot and/or an unexpected failover, you can try setting the `zsp.conf` file `vrrp_msg_rate` to 500.

The `VRRP_msg_rate` is the time in milliseconds between transmissions VRRP messages on the inter-switch link (ISL). The VRRP protocol requires the absence of three VRRP messages before concluding that the remote switch has failed. The `msg_rate` must match the `msg_rate` of all siblings. Anything other than multiples of seconds does not conform to the VRRP specification, and will only run with the `vrrpd`.

Unexpected Fail-back Activity

If unexpected fail-back activity is observed check to make sure that only one switch is setup as the Master switch (`vrrpd –M option`) or the switches will oscillate. See the Ethernet Switch Blade User's Guide for more information on setting the failover priority level.

Chapter 16 Switch Firmware Overview

There are three components to the firmware on the Ethernet Switch Blade:

1. Bootloader firmware (`zmon`)

2. OpenArchitect firmware

3. IPMI firmware

Some hardware and software problems can be resolved by updating the firmware to the latest version. Check the Hewlett-Packard website for the latest version (see the *HP 5700 ATCA 14-Slot Blade Server Installation Guide*).

Checking the switch firmware version

Use the `zstats -V` command to output the Vital Product Data from switch memory.

```
zstats -V
```

The following output is shown for the 3.0 Base Interface:

3.0 Base Interface

```
                sh-2.04# zstats -V
                VITAL PRODUCT DATA: Open Architect Advanced TCA Switch
                PN = 700-0170-003
                SN = 01BZ0X041HWP
                V0 = 00116509E000
                V1 = 1021
                V2 = 3
                V3 = Z
                V4 = 1
                V5 = 1
                V9 = 2
                EC = 00000000
                VA = 3800
                RV = 0x73
                V7 = 0
                V8 = 0
                V6 = 3.2.2 build g
                VS = 5
                VP = 1.70
                VM = 19
                VR = 4
                VZ = 4.42
                RW = 192 bytes
                VITAL PRODUCT DATA[1]: Port map ZX7120-HP
                VC = 030405060708091011121314H1
                VD = F0S2F2F3R0R1R2R31516S102H2
                VE = 224223432444254526462747H3
                VF = 284829493031323350513435H4
                VG = H3NCH1NCNCH2NCH4
                V9 = 2
                RV = 0x3b
                RW = 9 bytes
sh-2.04#
```

Key:
PN: Base Interface Switch Assembly Number
SN: Base Interface Switch Serial Number
V6: OpenArchitect Version Number
VP: IPMI Firmware Version
VZ: BootLoader Version Number

The following output is shown for the 3.1 Fabric Interface:

3.1 Fabric Interface

```
[ZX7100-OA3.2.2h]# zstats -V
VITAL PRODUCT DATA: Open Architect Advanced TCA Fabric
Switch
PN = 700-0174-002
SN = 01CS00029HWP
V0 = 0011650BC000
V1 = 1021
V2 = 3
V3 = Z
V4 = 1
V5 = 1
V9 = 2
EC = 00000000
VA = 3C00
VE =
22426282234363832444648425456585264666 86F4F5F6F7H1H2F8R8
VF =
27476787284829493050315132523353345435 55R4R5R6R7H1H2UCF9
Y6 = US45490039
Y7 = A-4546
RV = 0xba
V7 = 0
V8 = 0
V6 = 3.2.2 build h
VM = 3
VZ = 4.42
RW = 61 bytes
 [ZX7100-OA3.2.2h]#
```

Key:
PN: Base Interface Switch Assembly Number
SN: Base Interface Switch Serial Number
V6: OpenArchitect Version
VZ: BootLoader Version

Updating the Switch Firmware

Currently, the OpenArchitect and bootloader components are the only upgradeable firmware on the Ethernet Switch Blade. Upgrading the IPMI software is not currently supported.

BootLoader Firmware Upgrade:

1. Download the bootloader image to a local system.
2. FTP the bootloader image from the local system to your switch.
3. Use the `zflash` command to write the new `elgoro/zmon` image into the boot flash device. Be sure and use device 0, not device 1 or 2.

   ```
   zflash -d 0 <bootloader image name>
   ```

OpenArchitect Firmware Upgrade:

1. Refer to the *HP bh5700 14-Slot Blade Server Installation Guide*, *Chapter 6, 14-Slot Shelf Startup, Validating and Updating Your Firmware* for instructions on how to gain access to firmware updates for the HP bh5700 14-Slot Blade Server.
2. Use telnet, or preferably, attach a console cable to the switch, and login to the switch.

   I**MPORTANT: If you are connecting via `telnet`, be aware that the upgrade process will reset the switch to the default IP address of 10.0.0.42, so you will have to be able to reach 10.0.0.42.**
3. Using the procedures referenced in Step 1, above, download the OpenArchitect image upgrade to a local system.
4. Check for free space with the `df` command. The OpenArchitect image is very close to the limit of free space available on a default system, so you may need to clear some space prior to downloading the new OpenArchitect image to the switch.

   CAUTION: Do not remove the existing copy of `/usr/sbin/gated` (as suggested below) until you have, in fact, determined that an OpenArchitect upgrade version is available for downloading.

   One of the easiest ways to create free space is to remove `/usr/sbin/gated`, as the application will be replaced during the update procedure. Once you have enough free space, proceed.
5. From the switch console, `ftp` the new OpenArchitect image from the local system to your switch.

   The switch has two flash devices available: device 1 and device 2. Use the `zflash` command to write the new OpenArchitect image into the first flash device.

   IMPORTANT: Make sure that Surviving Partner is not running before using `zflash`. The delays incurred while `zflash` writes the flash can cause the

Surviving Partner daemons to think there is a failure, resulting in link oscillation.

```
Base Interface: zflash -d 1 rdr6000.zImage.initrd
Fabric Interface: zflash –d 1 rdr7100.zImage.initrd
```

IPMC Firmware Upgrade:

Upgrading the IPMC Firmware through OpenArchitect is not currently supported.

Chapter 17 Restoring the Factory Default Configuration

You should use this procedure if the contents in Flash Device 1 are corrupt and you need to restore the switch to the factory default configuration. By restoring the factory default configuration, you will overwrite your main file system in Flash Device 1 and lose all previous configuration changes.

IMPORTANT: Make sure that Surviving Partner is not running before using `zflash`. The delays incurred while `zflash` writes the flash can cause the Surviving Partner daemons to think there is a failure, resulting in link oscillation.

1. Connect through the console port. For more information, see Chapter 10, *Connecting to the Ethernet Switch Blade*.
2. When you see the number counter appear after the `zmonitor` ... banner, press any key on the console keyboard to enter the `zmon` application.
3. At the monitor prompt, type:

   ```
   boot:2
   ```

   You should see the counter again, but the system should boot into the secondary kernel.

   NOTE: If you have difficulties booting into Flash Device 2, the Flash Devices may have failed. Return the switch for repair.

   Use the `zflash` command to write the new OpenArchitect image into the first flash device:

   ```
   Base Interface: zflash -d 1 rdr6000.zImage.initrd
   Fabric Interface: zflash –d 1 rdr7100.zImage.initrd
   ```

CAUTION: DO NOT program flash 2, since currently this is your only bootable image.

Chapter 18 Before Calling Support

Because of the highly customized configurations that can be applied by customers to their ATCA switch environment, the focus must be on data collection to get a snapshot of the current switch configuration and network traffic activity. If support is needed, it is necessary to gather the following information for further diagnosis before calling support:

1. Get a network diagram showing key devices, VLANs, ports, IP addresses, packet flow, and amount and type of traffic (TCP, UDP, Broadcast, Multicast).
2. MAC addresses are useful as well.
3. Document a repeatable test case to reproduce the problem.
4. Obtain configuration scripts (the `S*` scripts run from the `/etc/rcZ.d` directory when the switch first boots).
5. Run `/etc/rcZ.d/tools/support_script.sh` and capture the output before and after the problem occurs. Navigate to the `/etc/rcZ.d/tools` directory and run the following script:.

   `/support_script.sh`

   NOTE: The support script may take up to 10 minutes to output a report.
6. Copy and paste the output into a .txt file for support personnel.

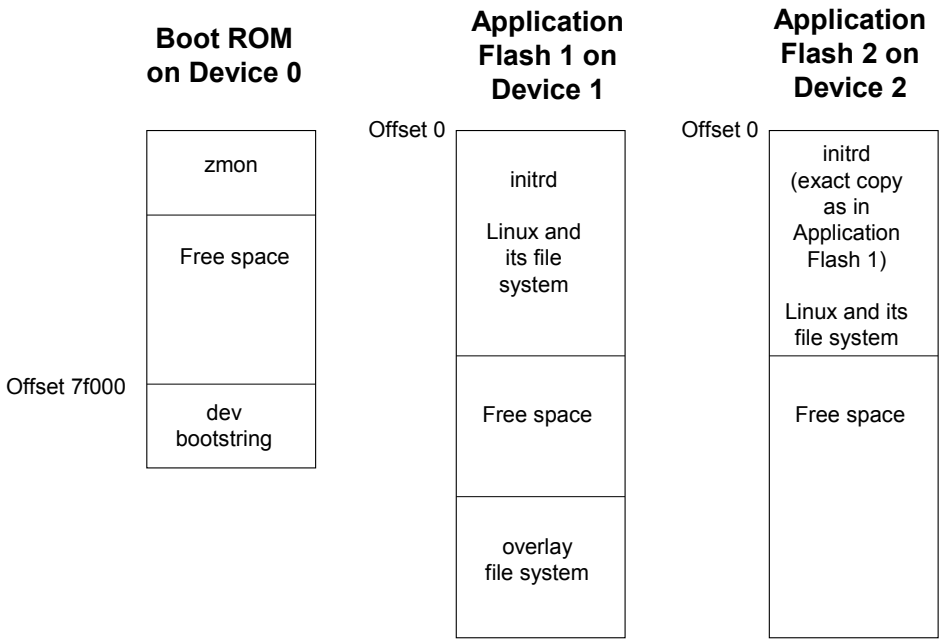


Figure 18.1: ROM Devices in OpenArchitect

The boot ROM is located on device 0 and contains the OpenArchitect `zmon` application that operates as a boot loader and includes a device bootstring. Device1 contains the application flash1 image of the Linux operating system and the OpenArchitect overlay file system. Application flash1 is the primary working image for the switch. Device 2 contains the application flash 2 that is an exact copy of application flash 1. You would only boot from this device if application flash1 is corrupted and you need to restore the switch to the factory-shipped configuration.

Appendix A Fabric Switch Command Man Pages

OpenArchitect applications are implemented above the OpenArchitect libraries and the RMAPI interface. OpenArchitect applications are used for normal operation of the switch, for runtime status and diagnostics, and for prototyping new applications development.

For runtime operation, the OpenArchitect applications perform initialization and configuration, and real-time control and maintenance of the switching tables in the switch silicon. Protocol support is performed by the Linux operating system. In turn the OpenArchitect applications communicate with Linux to determine the appropriate switch table setup.

The initialization of the switch is completed by the `zconfig` application. Through configuration scripts, the user can setup any combination of Layer 2 and Layer 3 switching configurations with VLAN support. Running the `zconfig` command causes network interfaces to be presented to the Linux operating system. These interfaces can be setup for Layer 2 bridging functions such as Spanning Tree Protocol, or Layer 3 routing through the Linux operating system.

`zl2d` is run as a daemon to monitor the Linux operating system bridging function and update the switch silicon accordingly.

`zl3d` is run as a daemon to monitor the Linux operating system routing table information and update the switch silicon switching tables accordingly.

For gathering statistics or prototyping applications, there are OpenArchitect applications that allow any register or table in the switch to be read or written. These applications include `zreg`, `ztats`, and `zarl` and all of the different table equivalents.

vrrpconfig

NAME

vrrpconfig – Configure and control the running vrrpd

SYNOPSIS

```
vrrpconfig [-d <level>] -- <vrrpd parameters>


vrrpconfig [-d <level>] [-k] [-a] [-p] [-s <vid>]
```

DESCRIPTION

vrrpconfig provides communication with a running vrrpd daemon. The -- option for vrrpconfig will pass all parameters to vrrpd as would be done when starting the vrrpd. Any output generated by vrrpd is displayed on the vrrpconfig controlling tty. Any action normally taken by vrrpd for the given parameter is done so by vrrpd. Reference vrrpd for vrrpd parameters and their usage.

OPTIONS

vrrpconfig also has a set of local options that are not passed to vrrpd directly. Many do, however, retrieve information from the running vrrpd. The local options are as follows:

```
-d <level> Set the debug level.  The default debug level is 1.
The higher the level, the more debugging output is produced.
Debugging output is sent to the controlling tty.  This
debugging output is from vrrpconfig.  To set the debug level
of vrrpd, one would use the vrrpd debug level setting option
placed after the -- in the vrrpconfig command line.

-a    Display in a user readable format, information about the
current state of all the Virtual Routers controlled by vrrpd.

-k    Kill vrrpd.  The entire daemon is killed.  Running this
command will require that vrrpd be restarted.

-p    Display relevant SNMP table values.

-s <vid>   Print a numeric representation of the state of the
Virtual Router associated with the Virtual Router Identifier
<vid>. The numeric representations are 1 = INIT, 2 = BACKUP,
and 3 = MASTER
```

EXAMPLES

Here is an example of using the -- invocation method that changes the priority to 99 for the Virtual Router associated with the Virtual Router Identifier 1:

```
vrrpconfig -- -v 1 –p 99
```

SEE ALSO

`vrrpd`

vrrpd

NAME

vrrpd – Virtual Router Redundancy Protocol Daemon

SYNOPSIS

```
vrrpd -i ifname -v vrid [-f piddir] [-s] [-a auth] [-p prio]
[-nhb] [-I ifname] [-d delay] [-m address] [-M ] [-B]
[-S script] [-c conf_file] [-D level] ipaddr
```

DESCRIPTION

vrrpd is an implementation of Virtual Redundant Routing Protocol (VRRPv2) as specified in RFC2338. It runs in Linux user space. In short, VRRP is a protocol that elects a Master server on a LAN to which the Master answers to a *virtual IP address*. If it fails, a Backup server takes over the IP address.

VRRP specifies an election protocol that dynamically assigns responsibility for a virtual router to one of the VRRP routers on a LAN. The VRRP router controlling the IP address(es) associated with a virtual router is called the Master, and forwards packets sent to these IP addresses. The election process provides dynamic failover in the forwarding responsibility should the Master become unavailable. This allows any of the virtual router IP addresses on the LAN to be used as the default first hop router by end-hosts. The advantage gained from using VRRP is a higher availability default path without requiring configuration of dynamic routing or router discovery protocols on every end-host.

OPTIONS

The following options are supported by vrrpd:

- h display the usage line

-n Don't use the virtual MAC address

-b Run vrrpd in foreground

-i <ifname> the interface name on which to run the Virtual Router. Machines connected with the named interface will see the Virtual Router Address move with the Master switch

-I <ifname> the interface name on which to communicate with other VRRP routers for management of the Virtual Router (default is the -i interface)

-v <vrid> the id of the Virtual Router Identifier [1-255]. This value must be a unique value, one per Virtual Router. In other words there is a unique vrid to ifname associated with

the –i option.

-s Toggle preemption mode (Enabled by default). Preemption means that a Master switch will go to Backup if a current Backup has higher priority.

-M Become MASTER when priority is equal. Be sure it is only set on one host or the switches will oscillate. Must set –B option on other hosts (requires preemption mode ! -s)

-B Become BACKUP when priority is equal. See -M option

-S <script> script to be called when state change occurs.

-a <auth> (not yet implemented) set the authentication type auth=(none|pass/hexkey|ah/hexkey) hexkey=0x[0-9a-fA-F]+

-p <prio> Set the priority of this host in the virtual server (default is 100)

-f <piddir> specify the directory where the pid file is stored (default is /var/run)

-c <conf> Configuration read from conf file (required when managing multiple Virtual Routers). The contents of the conf file are lines of command line options. Each line represents a Virtual Router. Parameters given on the command line apply to all Virtual Routers defined by the conf file. So for example, if the command line reads:

vrrpd –d 50 –c vrrpd.conf

And the vrrpd.*conf* file contains:

-v 1 –i zhp0 –I zhp3 10.0.0.43

-v 2 –i zhp1 –I zhp3 11.0.0.42

vrrpd would be started controlling two Virtual Routers; one for 10.0.0.43 and the other for 11.0.0.42. They would both get a –d 50 option.

-d <delay> Set the advertisement interval. Default is 1 second. By default time is specified in seconds. If the delay value ends in a lower case 'm' the time is specified in milliseconds. The millisecond specification results in a proprietary use of the VRRP Adver Int field.

-m <address> Change the virtual MAC address from 00:00:5E:00:01:<vid> to the provided addr. The addr should be input as 6 two digit hex numbers that are colon delimited with no spaces. The –n option overrides the change made with –m.

```
   The result of which to use the native MAC address of the
   interface.  Using the –n option is not recommended.

   -D <level> Set debugging output to the supplied level

   <ipaddr>   the ip address(es) of the virtual server
```

SEE ALSO

vrrpconfig

zbootcfg

NAME

zbootcfg – Modifies the boot parameters of the OpenArchitect switch.

SYNOPSIS

```
zbootcfg -a | -d <device number> [<boot_string>]
```

DESCRIPTION

zbootcfg is used to display or modify the boot parameters on the switch. The boot parameters are utilized by the minof boot loader application to indicate on which device to find a boot image. Care should be taken when changing the boot string. Incorrect procedures can result in a switch that cannot boot.

```
-d <device_number>
Three ROM boot devices are available in the switch. The
factory-shipped boot device is 1. The following describes each
boot device:

-d 1  Boot image located at offset 0 in the application flash
1. This is the factory-shipped location of the primary
OpenArchitect image.

-d 2  Loads an image located at offset 0 in the application
flash 2. This is the factory-shipped location for the
alternate OpenArchitect image.
```

Any characters after the -d <dev> parameters are saved in flash memory and passed unchanged to the booting kernel.

OPTIONS

```
-a    Displays the current boot string. The default factory
shipping string is "dev1."

-d <dev>   Specifies the ROM device from which to boot. The
<dev> value must be the number 1 or 2 corresponding to
application flash 1 or application flash 2, respectively.

<boot string>   Optionally, a boot string may be provided that
is passed to the booting kernel. All characters after the -d
<dev> are passed unchanged to the booting kernel.
```

EXAMPLES

The following example illustrates a command for making the image boot from the second

application flash. Typically this is required before updating application flash 1. By booting the alternative image, if a failure occurs during the programming of application flash 1, recovery is easier.

```
zbootcfg -d 2
```

The next example passes the *-i* option to the booting kernel. This is useful when recovering from a mistake saved to the read-write file system or after updating the application flash 1 and doing the first boot. The *-i* option prevents the read-write file system from overwriting the initial RAM disk image.

```
   zbootcfg -d 1 –i
```

SEE ALSO

`zflash, reboot(8)`

zconfig

NAME

zconfig - Configures the OpenArchitect switch.

SYNOPSIS

```
zconfig [-h <host_name>] [-d <level>] [-a] [-t] [{-f <file>} |
<configuration>]
```

DESCRIPTION

zconfig creates Virtual Local Area Network (VLAN) groups of switch ports or trunks. Each VLAN group forms a Layer 2 switching domain. Each VLAN group has a VLAN Identification number (VID) that can be carried in a tag field, located in the header of packets traveling on that VLAN. The configuration of a port determines whether a packet transmitted from that port includes the VLAN tag. A set of up to eight ports may be configured as a trunk, with all links from these ports connect to the same link partner. For each VLAN group created by zconfig, a network interface is also created. After the network interface is started by ifconfig(1M), the VLAN group performs Layer 2 switching. The network interface can be used for Layer 3 routing between VLAN groups.

A network interface uses the following format:

```
zhpN (e.g., zhp0)
```

N-is an integer between 0 and 9999. The value of N is not required to be the same as any of the port(s) that are its members. The range 0-4999 is reserved for network interfaces created by users. The range 5000-9999 is reserved for network interfaces created by switch applications.

A trunk uses the format zrlK, where K is an integer between 0 and 31.

OPTIONS

```
-h <hostname>   Specifies the hostname to configure.  By
default, zconfig configures the local OpenArchitect switch.

-d <level> Sets the level of debugging output produced by
zconfig. The default level is 1.  Setting the debug level
higher produces more output. The maximum output level is
currently four (4).

-a   Displays the current configuration of the switch.

-t   Tears down the entire switch configuration.

{-f <file>} | <configuration>
Gets configuration information from the specified file.  A
<file> name of '+' reads configuration data from standard
```

```
input.  If the -f  flag is not used, a single line of
configuration data can be entered as parameters to zconfig.
```

CONFIGURATION SYNTAX

`zconfig` takes configuration data from standard input or from a file with the `-f` option. In either case, the configuration syntax is the same. The `zconfig` configuration data consists of a list of semicolon-delimited statements. Each statement specifies an action to take globally or on an interface. An interface is one of three types: a network interface called `ZNYX host port` (`zhp`); a switch port interface called ZNYX Raw Ethernet (`zre`); or a trunk interface called ZNYX RainLink (`zrl`).

Comments, spaces and new lines are ignored. Comments begin with the # character and include characters through the next new line.

Global Statements

Global statements can be used to set modes of operation on a switch-wide basis. The only supported global statement is to set and teardown Double VLAN tag mode.

Global Statement Syntax:

Double VLAN tag mode is set and removed on a global basis with the following syntax.

```
dvlan 0x8100 | 0x9100;   (or other unused ethertype)

dvlan teardown;
```

The first option sets double VLAN tag mode on all ports and establishes the outer tag id. The second tears down double VLAN tag mode.

Trunk Interface Statements

A trunk interface statement begins with the trunk name followed by an equals sign and an action. Trunk interface statements are used to create or tear down trunks or define the rules to determine which member of the trunk should be used to transmit a packet

Trunk interface syntax:

```
zrl0 = <Trunk Interface Action>;
```

Trunk interface actions:

```
List of ports   Creates a trunk interface with the specified
port members.  All of the ports specified must not be a part
of any other trunk, or be individually included in any network
interface.  Up to eight ports can be included in a trunk.

A port member is identified with the zre<X> format, where x
represents a port number between 0 and 23 for the in-band
ports. The Out of Band ports cannot be included in the List of
```

ports.

teardown Removes the trunk interface, making the ports which were part of the trunk available for configuration in other trunks or VLANs.

all

mac [source_address | destination_address]

ip [source_address | destination_address]

port [source_port | destination_port]

Further specifies the rules for selecting which port in the trunk a packet should be transmitted out of. A comma delimited list is valid to specify more than one criterion. Specifying a particular option only uses that layer's source and destination information. The default is all, which combines all criteria for determining the transmit port of the trunk. Specifying both source and destination for a given layer is the same as specifying that layer itself, i.e,

zrl0=ip source_address, ip destination_address

is the same as,

zrl0=ip

NOTE: The Ethernet Switch Blade supports `destination_address` and/or `source_address` for `MAC` and `IP`. It cannot combine `MAC` and `IP` settings, nor does it support port settings.

Examples of trunk interface statements:

This statement creates a trunk containing three ports:

```
zrl5 = zre11,zre15,zre17;
```

The following statement specifies that packets will be sent out over this trunk using the exclusive OR of the last four bits of their MAC source and destination addresses to select the port:

```
zrl5 = mac source_address, mac destination_address;
```

The teardown statement uses a colon instead of an equals sign:

```
zrl5: teardown
```

Network Interface Statements

The syntax for a network interface statement is the interface name followed by a colon and an action. Network interface statements are used to create or tear down a VLAN group and can consist of one or a list of network interface names; followed by a colon and then an action. For example:

```
zhp0: <Network Interface Action>;
```

Network interface actions may include:

```
vlan<N> = list of ports or trunks
Creates a network interface and a VLAN group with a VLAN
identification number (VID) consisting of specified port
members.

<N>   is an integer between 1-4095.

list of ports or trunks
A port member is identified with the zre<X> format, where x
represents a port number between 0-23 for the in-band ports. A
trunk is identified with the zrl<Y> format, where Y is a
number between 0-31.

If the network interface and VLAN group already exist, the
specified ports or trunks are added to the network interface
and VLAN group.

teardown   Deletes the network interface and the associated
VLAN group.

zre_list = multicast <mac_address>
Register the multicast <mac_address> on the zre_list ports
associated with the given VLAN

multicast_clear Clear all registered multicast address on all
the ports in the VLAN

<list of ports or trunks>  teardown
Deletes the specified ports or trunks from the network
interface and the VLAN group associated with it. If there are
no remaining port or trunk members, then also deletes the
network interface and VLAN group.
```

Examples of Network Interface Statements:

The statement below creates a VLAN group with the VID number 1 and the network interface named zhp5. This VLAN includes a single switch port, zre1.

```
zhp5: vlan1=zre1;
```

The next statement creates a VLAN group with the VID number 100 and the network interface

named zhp1. This VLAN includes four switch ports, zre1, zre10, zre11, zre13.

```
zhp0: vlan100 = zre1,zre10,zre11,zre13;
```

The next statement adds two switch ports, zre1, zre2 and zre3, to an existing network interface and VLAN.

```
zhp0: vlan100 = zre1..3;
```

The next statement deletes two switch ports, zre1 and zre2, to an existing network interface and VLAN.

```
zhp0: zre1..2 teardown;
```

The final example is a teardown action that deletes the VLAN group defined in the previous example, including the network interface.

```
zhp1: teardown;
```

Port Interface Statements

Port interface statements specify a port or trunk name or a list of such names; followed by an equal sign (=) and then the action. Port interface actions may include:

SYNTAX

```
zconfig <zre_list>=untag<n>

untag<N>   Packets sent from this port or trunk for VLAN <N>
are transmitted without a VLAN tag. The port or trunk
specified must have previously been included in the VLAN group
with VID<N>.

zconfig <zre_list> multicast=<forward_type>

<forward_type>  Set the ports specified to act as defined by
the forward_type for multicast traffic.  Possible
<forward_types> are:

forward_unregistered  (default)
forward_all
filter_unregistered
```

Examples of Port Interface Statements:

Assuming that zre1 has been assigned to VLAN 1, to specify that packets sent from port 1 for VLAN 1 are transmitted without a VLAN tag, and packets arriving on this port without a VLAN tag are given the VLAN tag with the VID number 1, enter:

```
zre1=untag1;
```

If port 0 is also a member of VLAN 100, packets for VLAN 100 are sent from this port with a VLAN tag as part of their header.

In the next example, the switch ports 10, 11, and trunk 2 are configured as untagged members of VLAN 100.

```
zre10,zre11,zrl2=untag100;
```

This statement is equivalent to the following three lines:

```
zre10=untag100;

zre11=untag100;

zrl2=untag100;
```

In the examples above, since port interfaces can only be untagged for one VLAN group, `zre1` cannot also be untagged for VLAN 100. A port or trunk can be a member of multiple VLANs but can only be designated untagged on one VLAN.

WILDCARDS

Wild card characters can be included to simplify the process of creating larger, more complex configurations. Wild card characters for `zconfig` include:

```
,   (comma)     Use for creating lists

..  (dot-dot)   Specifies an inclusive range

+  (plus)  Specifies auto-incrementing
```

Below are some examples for the correct usage of the comma (,) and dot-dot (..). Each line below produces the same results:

```
zhp0: vlan1 = zre1, zre2, zre3, zre4;

zhp0: vlan1 = zre1..4;

zhp0: vlan1 = zre1, zre2..4;

zhp0: vlan1 = zre1..2, zre3..4;
```

The following examples create multiple VLAN groups using a single statement. A list of network interface names are followed by a colon (:) and a list of VLAN actions which are followed by an equal sign (=) and a port list. Each VLAN group is created in turn, along with the corresponding network interface, and all ports listed after the equal sign are included in each group.

The following statement creates 14 VLAN groups with VID numbers 1-14. Each VLAN contains the same switch port, port 1, represented as zre1.

```
zhp0..13: vlan1..14 = zre1;
```

The plus (+) wildcard can be used with the last port listed to auto-increment that port number before each VLAN group is created. The following network interface statement creates 14 VLAN groups, with the first group containing port 1, the second group port 2, and so on. The second statement configures all ports as untagged in their respective VLANs.

```
zhp0..13: vlan1..14=zre1+;
zre1..13=untag1+;
```

This is equivalent to:

```
zhp0: vlan1=zre1;
zhp1: vlan2=zre2;
zhp2: vlan3=zre3;
      .
      .
zhp13: vlan14=zre14;

zre1=untag1;
zre2=untag2;
zre3=untag3;
      .
      .
zre14=untag14;
```

The previous configuration can be used for creating a 14 port Layer 3 switch, with each port assigned to its own VLAN.

In the next example, one VLAN group, with VID number 1, is created that contains 14 ports. The second statement designates the 14 ports as untagged for the VLAN 1 group.

```
zhp0: vlan1 = zre1..13;
zre1..13 = untag1;
```

The previous configuration can be used for creating a 14 port Layer 2 switch, all 14 ports assigned to the same VLAN.

SEE ALSO

`zl3d`

zcos

NAME

zcos - class of service queue control

SYNOPSIS

```
zcos    [-h <hostname>] [-d <level>]

[ -u <default priority> ]

[ -m q0,q1,q2,q3,q4,q5,q6,q7 ]

[-n <queue length list in packets for each queue> |

 -b <Reserved space in bytes for each queue> |

 -s <limit on dynamic pool usage, in bytes>, <reset %>]

 [ -k PRI | RR | WRR | DRR]

[ -w <queue weight list> ]

[ -g <max>,<burst> ]

[ -r <guaranteed bandwidth in Kbps for each queue> [ -t <burst
size list in Kbytes> ]

[  -l <maximum bandwidth in Kbps for each queue>  [ -t <burst
size list in Kbytes> ]

[ -q all | qmap | qinfo | scheduler ]

[<port list>]
```

DESCRIPTION

zcos provides a means to set many of the hardware features of the switch related to class of service and differentiated services processing, including scheduling and bandwidth management. The current settings can also be examined.

The OpenArchitect switch supports up to eight class of service queues for packets to be sent out each of the Ethernet ports or forwarded to the CPU. Normally, packets are placed in these queues based on their 802.1p priority for tagged packets or the default priority for the port on which they arrive. The queue destination for each priority is determined by a map. A separate map is used for each ingress port. For additional means of setting the cos queue for a packet, see the sections on filtering and traffic control.

Packets are selected from the cos queues at a port based on a scheduler, which may be configured in a variety of modes. The scheduler can provide minimum bandwidth guarantees and limit the bandwidth used for packets from each cos queue. The total egress bandwidth for a port can also be limited.

Each cos queue is limited in the number of packets it can hold waiting scheduling; the memory used by each queue is managed to provide a guaranteed space with additional space shared among all queues for a port.

OPTIONS

Most options are optionally followed by a <port list>, which may include zre port ranges, like zre0..5, individual ports, such as zre51, or cpu, to indicate the queues and scheduling for packets to be transferred to the cpu. The priority and queue mapping options do not apply to the cpu, these settings are provided by the host.

General Options

-h <hostname>

Specifies the hostname of the OpenArchitect switch to be configured. Ignore this option if you are configuring on the OpenArchitect switch on which the zcos command is being run.

-d <level>

Sets the debug level. The default is 1. The maximum is 4.

Priority and Queue Mapping

-u <default priority> [<port-list>]

Packets which arrive without a tag have no 802.1p priority. This option assigns a default priority for untagged packets arriving on each port in the <port-list>. The default priority ranges from 0 (lowest) to 7 (highest).

-m q0,..,q7 [<port-list>]

Specifies the priority to COS queue map. The first parameter maps priority 0 to queue q0, second maps priority 1 to queue q1, etc. (the queues are numbered 0 to 7). The <port-list> identifies which ingress ports will use this map. If no <port-list> is given, the same map will be used for packets arriving on any of the input ports.

Queue Limits

(These limits should only be changed when the ports are idle)

-b <Reserved space in bytes for each queue> [<port-list>]

Specifies the dedicated memory for each cos queue of the ports listed.

-n <queue length list in packets> [<port list>]

Sets the number of packets allowed on each cos queue of the ports listed. The total number of packets for all 8 cos queues is limited to 2048.

-s <limit on dynamic pool usage, in bytes>, <reset %> [<port list>]

Sets the limit on dynamic memory pool usage by all cos queues for each port listed.

Packets are first counted against the reserved space for a queue. When that space is occupied, additional memory is used from the dynamic memory pool until the dynamic pool usage limit for the port is reached. Any additional packets received for the queue on this port are dropped.

Metering and Scheduling

```
-r <list of bandwidth guarantees in Kbps for each cos queue> [
-t <list of burst sizes in Kbytes>]

[<port-list>]
```

Sets up minimum rate meters for each cos queue. All queues which have not exceeded their minimum transmission rate are scheduled before the other queues.

```
-l <list of bandwidth limits in Kbps for each queue> [ -t
<list of burst sizes in Kbytes>] [<port-list>]
```

Sets up maximum rate meters for each cos queue. Queues which have exceeded their maximum transmission rate will not be scheduled.

```
-k PRIO | RR | WRR | DRR [<port list>]
```

Selects the scheduler mode for the ports listed:

PRIO – strict priority, cos queue 7 is highest priority, queue 0 is lowest

RR – Round robin, a single packet is scheduled from each backlogged COS queue.

WRR – Weighted round robin, a configurable number of packets are scheduled from each queue before moving on to the next.

DRR – Deficit Round Robin, packets are scheduled from a backlogged queue until the configured number of bytes for that queue have been sent.

```
-w <queue weight list> [<port list>]
```

Provides the weights for WRR and DRR scheduling. For WRR, the weights are the number of packets, scaled such that all weights are between 1 and 15. For DRR, the weights are the number of bytes, with a range of 10KB to 160 MB of data.

```
-g <max Kbps>,<burst size in KBytes> [<port list>]
```

Sets a maximum bandwidth meter for all packets transmitted from a port.

The guaranteed and maximum rate meters influence the four scheduling modes. First, those queues which have not met their guaranteed rate and have packets to send are serviced according to the scheduling mode. Then those queues which have not met their maximum rate and have packets to send are serviced. If all queues have met their maximum rate, or the maximum bandwidth for the port has been reached, no packets are sent. Each of the meters is implemented as a separate leaky bucket.

Queries of the Current Settings

```
-q all | qmap | qinfo | scheduler [<port list>]
```

Queries the current COS/QOS Settings.

`all` - Displays all of the queue mappings, queue limits, metering and scheduling settings

`qmap` - Displays the priority to COS queue mappings.

`qinfo` - Displays queue limits for the COS queues.

`scheduler` - Displays the traffic metering and shaping settings and the scheduler mode.

EXAMPLES

1. To set Ethernet ports `zre0` to `zre19` to allow up to 50 packets in priority queues 0-3 and up to 75 packets in queues 4-7:

```
zcos –n 50,50,50,50,75,75,75,75 zre0..19
```

2. To map packet priorities 1-1 to COS queues for packets received on all ports:

```
zcos –m 0,1,2,3,4,5,6,7
```

3. To set up weighted round robin scheduling on ports `zre10` to `zre14` and the CPU with a weight of 2 for queue 0, 3 for queue 1, and 1 for all other queues:

```
zcos –k WRR –w 1,3,1,1,1,1,1,1 zre10..14,cpu
```

4. To limit the rate of packets sent to the CPU to 15 Megabits/sec., with bursts of no more than 20,000 bytes:

```
zcos –g 15000,20 cpu
```

5. To guarantee CPU cos queue 5 500 kbps, queue 6 200 kbps, and queue 7 1 mbps, and all other queues no guarantee:

```
zcos –r 0,0,0,0,0,500,200,1000 cpu
```

6. To limit CPU cos queues 0 – 4 to 1000 kbps, with a burst of 20 Kbytes:

```
zcos –l 1000,1000,1000,1000,1000 –t 20,20,20,20,20 cpu
```

SEE ALSO

`zfilterd, zqosd, ztmd`

zdog

NAME

zdog - Configure and send heartbeats to watch dog enabled drivers.

SYNOPSIS

```
zdog [-d <level>] -h | -i <interval> | -n <heartbeats>

zdog [-d <level>] -b

zdog [-d <level>] -a
```

DESCRIPTION

zdog is used to configure the Ethernet Switch Blade watchdog timer functions and to send heartbeats to the Ethernet Switch Blade watchdog drivers. There are two components to the Ethernet Switch Blade watchdog timer: A hardware component and a software component. The two components are independent from each other in implementation, but work together to provide safety against zombie hardware and software. The hardware component requires attention on a predefined 1.5 second interval. The driver acts on this at interrupt level to ensure that spurious reboots do not occur. The software component allows for a user programmable interval on which lack of application to driver communication will cause a reboot. Both components can be turned on with zdog.

The options -i and -n are used to configure the expected interval of heartbeats and the number of missed heartbeats of the software component before the Ethernet Switch Blade should be rebooted. If either the interval or number of heartbeats is 0, the software component is off. The -h option is used to toggle on and off the hardware component of the watchdog timer. The hardware component is off by default.

Once the software component of the watchdog timer is turned on, a heartbeat must be sent with the -b option within that interval or the system will reboot. For example after issuing the following command:

```
zdog -i 5000 -n 3
```

A heartbeat must be sent at least every 3*5000=15000 milliseconds (every 15 seconds). This can be accomplished with something as simple as a polling script with a sleep, or started with a higher level function like monit. The driver checks for heartbeat timeout approximately 3 times per second. So (<heartbeat intervals>*<number of heartbeats>) faster then 330 milliseconds will have diminishing returns.

Combining monit and zdog allows multiple levels of insuring system integrity. The hardware

component of `zdog` insures that the CPU is functioning well enough to execute something. The software component of `zdog` when launched from `monit` insures that `monit` is running to perform higher level tasks. And finally `monit` can be used to monitor any or all critical system resources and processes in the system.

OPTIONS

```
-d    set debug level to <level>

-h    Toggle use of the hardware watchdog timer.  Off by
default.

-i    Time interval in milliseconds between zdog to driver
heartbeats

-n    Number of missed heartbeats before system reboot

-b    Send a single heartbeat to the driver

-a    Display current configuration
```

SEE ALSO

`http://www.tildeslash.com/monit/`

zfilterd

NAME

zfilterd - A daemon to use the filter hardware of the OpenArchitect switch for filtering based on iptables(8) rules.

SYNOPSIS

```
zfilterd [-d <level>] [-p <port>] [-f] [-l] [-i <pid>]
[-o <pid>]
```

DESCRIPTION

zfilterd is a daemon that intercepts filtering rules entered by the user, using iptables(8), checks them for validity and then prepares messages for the traffic management daemon ztmd, which is responsible for setting up the switch hardware for the filtering rules and actions.

OPTIONS

-d <level> Sets the level of debugging output required by zconfig. The default level is one (1). Setting the debug level higher produces more output. Four (4) is currently the maximum output level.

-p <port> Set the multicast port to which messages will be sent.

-f Run zfilterd in the foreground, by default, it runs in the background.

-l Log all diagnostic output to /var/log/zfilterd.log.

-I <pid> Set our pid used in identifying ourselves to ztmd

-o <pid> set the pid of the ztmd process we will communicate with.

SEE ALSO

ztmd, zrule, iptables(8)

zflash

NAME

zflash – Loads images into the flash ROMs on the OpenArchitect switch.

SYNOPSIS

```
zflash -d <dev> [-o|-O <offset>] <image_file>

 <upgradeipmi.img>
```

DESCRIPTION

zflash enables you to program the flash ROMs on the switch. The switch contains 3 flash ROM devices: the boot ROM flash, application flash 1 and application flash 2. Care should be taken when flashing new images into the switch. Incorrect procedures can result in a switch that cannot boot; especially when flashing the boot ROM referred to as device 0. See *Switch Maintenance* for updating the flash ROM images.

OPTIONS

-d <dev> Specifies the ROM device being programmed. Dev must be a number 0, 1, or 2 corresponding to the boot ROM, application flash 1, or application flash 2 respectively.

-i <upgradeipmi.img> will load the file <upgradeipmi.img> into the IPMI controller flash memory. This updates the program version, it does not affect the FRU data.

   Progress indicators will be printed during the update. It may take four minutes to flash.

   Once the update is complete, the IPMI controller is rebooted, which may cause the shelf manager to temporarily disable fabric ports until the reboot is complete.

EXAMPLES

The following example loads a new initial RAM image into application flash 1 at the default offset of 0:

```
zflash -d 1 rdr6000.zImage.initrd
```

The following example loads a new boot image into the boot ROM at the default offset of 0:

```
zflash -d 0 zx6000.img
```

Exercise caution when using this command, as an error can render your switch inoperable. Do not interrupt this process until complete.

SEE ALSO

`zbootcfg`

zl2, zl2mc, zl3host, zl3net, zvlan

NAME

`zl2, zl2mc, zl3host, zl3mc, zl3net, zvlan` – Formatted display of OpenArchitect generic tables.

`zl2` displays the abstraction API's layer 2 table.

`zl2mc` displays the abstraction API's layer 2 multicast table.

`zl3host` displays the abstraction API's layer 3 host route table.

`zl3mc` displays the abstraction API's layer 3 multicast table.

`zl3net` displays the abstraction API's layer 3 network route table.

`zvlan` displays the abstraction API's VLAN table.

SYNOPSIS

```
zl2 [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-P port] [-h <host_name>] [-d <level>]


zl2mc [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-P port] [-h <host_name>] [-d <level>]


zl3host [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-P port] [-h <host_name>] [-d <level>]


zl3mc [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-P port] [-h <host_name>] [-d <level>]


zl3net [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-P port] [-h <host_name>] [-d <level>]


zvlan [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-h <host_name>] [-d <level>]
```

DESCRIPTION

The generic table display functions produce formatted output of the abstraction API's tables for

display on the user console. The format of the output is table-dependent. Port mapping affects the ports referenced in the generic tables. (Ports listed in order from 1 to 15)

Headers describing the column being displayed are printed after every 22 lines of output, which makes it easy to pipe through *more(1)*. The abstraction layer tables grow and shrink as entries are added and deleted.

Several options are available which enable the user to display only selected entries. Additionally, there is an option that clears user-specified entries in the table.

OPTIONS

```
-i <index> Displays the entry at the <index> position in the
table. Valid for all tables. Cannot be combined with -m, -P or
-v.

-m <mac_address>
Displays entries whose MAC address field matches
<mac_address>. Only valid for tables that have a MAC address
field. Cannot be combined with -i, -P, or -v.

-a   Displays the entire table.

-v <vlan_id>    Displays entries whose VLAN ID field matches
<vlan_id>. Only valid for tables that have a VLAN ID field.
Cannot be combined with -i, -m, or -P.

-P <port>  Displays the entries whose port field matches
<port>. Only valid for tables that have a PORT ID field.
Cannot be combined with -i, -m, or -v.

-h <host_name>  Specifies which hostname to connect. By
default, zgr connects to the locally connected OpenArchitect
switch (i.e., the one that is on the local PCI bus).

-d <level>      Sets the level of debugging output required by
zgr. The default level is one (1). Setting the debug level
higher produces more output. Four (4) is currently the maximum
output level.
```

EXAMPLES

The following example searches for and displays an entry in the `zl2` table with the specified MAC address:

```
zl2 -m 00:c0:95:45:00:00
```

If there is an entry in the `ZL2` table with the MAC address, 00:c0:95:45:00:00, all the fields of that entry will be displayed.

The following command deletes the above entry:

```
zl2 -c -m 00:c0:95:45:00:00
```

The following command displays all entries of the `zl2` table:

```
zl2
```

Be careful, the *-c* option does not ask. The following command deletes all entries in the `zl2` table:

```
zl2 -c
```

SEE ALSO

`zal`

zgvrpd

NAME

zgvrpd - GARP VLAN Registration Protocol (GVRP) daemon for the OpenArchitect switch.

SYNOPSIS

```
zgvrpd [-d <level>] [-f] [-h <hostname>] [-p <ppa>] [-t
<target>]
```

DESCRIPTION

zgvrpd is run after the network interfaces are created and initialized with zconfig, and started with ifconfig(1M).zgvrpd starts a background task that implements the GARP VLAN Registration Protocol (GVRP) protocol for a specified zhp interface. GVRP provides a Layer-2 mechanism for dynamically managing port membership in VLANs, including adding and deleting ports, and creating and deleting VLANs. The background task started by zgvrpd continues throughout the life of the Layer 2 network. GVRP is specified in *ANSI/IEEE Std 802.1Q, 1998 Edition*. The GARP protocol on which GVRP is based is specified in *ANSI/IEEE Std 802.1D, 1998 Edition.*

zgvrpd updates the switch's VLAN configuration, based on GVRP packets received on the target interface. Specifically, it adds a port to or deletes a port from the VLAN specified in the GVRP packet. If the VLAN does not exist, zgvrpd creates it. If zgvrpd deletes the last port from a dynamically-created VLAN, it also deletes the VLAN.

When a VLAN is dynamically created, a corresponding zhpN interface is also created, where N is an integer between 5000 and 9999. The value of N is equal to 5000 plus the VLAN identification number (VID). For example, if zgvrpd creates VLAN 5, it also creates a zhp5005.

zgvrpd learns the existing (static) VLAN configuration of its target when starting up. When shutting down, zgvrpd deletes only the dynamic changes to the VLAN configuration that it has made. Manual changes to the VLAN configuration can be made while zgvrpd is running. However, all such changes will be deleted when zgvrpd is terminated.

Only the GARP normal registration mode is currently supported. Multiple instances of zgvrpd may run concurrently provided the targets are unique. If zgvprd's target is a zhp, it's recommended that the zhp contain all the ports on the switch.

zgvrpd cannot be run concurrently with zsnoopd, because zsnoopd assumes static VLAN membership.

OPTIONS

```
-d <level>
Sets the level of debugging output required by zgvrpd. The
default level is zero (0). Setting the debug level higher
produces more output. Five (5) is currently the maximum output
level.

-f   Run zgvrpd in foreground. Default is to run it in
background.

-h <hostname>
Connect to remote host <hostname>.

-p <ppa>
Start zgvrpd on switch <ppa>. Default is 0.

-t <target>
Enable GVRP on the set of ports specified by the target zhp
interface. There is no default. A target must be specified.
```

EXAMPLES

In the following example, `zgvrpd` starts a background task that enables the GVRP protocol for the ports in the `zhp0` interface. `zgvrpd` receives and sends GVRP packets, and updates the VLAN configuration accordingly. This background task continues throughout the life of the Layer 2 network, or until manually terminated.

```
zgvrpd –t zhp0
```

Once you run `zgvrpd`, use `zconfig -a` to display the current VLAN configuration.

SEE ALSO

`zconfig, zsnoopd`

zl2d

NAME

zl2d - Layer 2 daemon for the OpenArchitect switch.

SYNOPSIS

```
zl2d [start | stop] [-t <msecs>] [-d <level>] [-f]
     [-p <priority>] <iface..>
```

DESCRIPTION

zl2d is run after the network interfaces are created and initialized with zconfig. zl2d creates a Linux bridge for each interface using brctl(8). The bridge name is the interface name with a 'b' pre-pended to it. This command is primarily used for Rapid Spanning Tree Protocol (RSTP). Each port associated with the interface is included within the bridge. zl2d starts a background task that continues throughout the life of the Layer 2 network. zl2d is a script that can be modified to include brctl commands when started and stopped. Examine /usr/sbin/zl2d for examples of how to change common options.

OPTIONS

start | stop Starts or stops the zl2d daemon.

-t <msec> Cause zl2d to monitor the Spanning Tree state of each port on each bridge every <msec> milliseconds. If unspecified, the default is 500 milliseconds.

-f Enables Fast Forward on bridge(s) using 0x4000 (16384) as the dynamic root priority.

-d <level> Sets the level of debugging output required by zl2d. The default level is one (1). Setting the debug level higher produces more output. Four (4) is currently the maximum output level.

-p <priority> Sets the dynamic root priority. <priority> should be specified as a decimal number. A priority of 0 disables root priority change.

<iface…> The network interfaces on which zl2d should operate. These network interfaces must first be created by zconfig. zl2d does not operate with standard network interface cards. It only works on switch network interfaces created by zconfig.

OPERATIONS

`zl2d` manages the Spanning Tree state fields in the switch of each port within the bridge(s). Based on a timer, `zl2d` reads the port information for each Linux bridge and updates the switch when necessary.

EXAMPLES

In the following example, `zl2d` creates a Linux bridge named `bzhp0` which includes all of the `zre<n>` devices previously associated with the `zhp0` device. `zl2d` then starts a background task that monitors the port information of the Linux bridge every 500 ms. and updates the Spanning Tree state fields in the hardware when necessary.

```
zl2d -t 500  zhp0
```

Once you run `zl2d`, use `brctl(8)` to display and alter your Spanning Tree settings.

SEE ALSO

`zconfig, brctl(8)`

zl3d

NAME

zl3d - Layer 3 daemon for the OpenArchitect switch.

SYNOPSIS

```
zl3d [-h <host_name>] [-t <msecs>] [-b] [-e] [-l] [-n] [-d <level>]
<iface ..>
```

DESCRIPTION

zl3d is run after the network interfaces are created and initialized with zconfig, and started with ifconfig(1M).zl3d listens for Netlink messages from the kernel and monitors the Linux network routing tables for routing updates. When an update occurs, if appropriate, zl3d updates the corresponding routing tables in the silicon so that Layer 3 forwarding is done in the switch at line speed. zl3d also ages the switch host route entries.

zl3d attempts to keep the Linux route cache and the switch host route table consistent. When a host route table entry is in use, zl3d updates the Linux route cache. Host route table entries are deleted when Linux removes the corresponding entry from the route cache. Similarly, network route entries are removed when the corresponding Linux FIB table entry is deleted.

OPTIONS

-h <hostname> Specifies which host to monitor. By default, zl3d monitors the OpenArchitect switch that is locally connected (i.e., the one that is on the local PCI bus).

-t <msec> Sets the timeout value. By default, zl3d wakes up every 15 seconds (15000 ms) to look for updates to the Linux routing tables and to do aging processing of route table entries on the switch.

-b Do not background the zl3d process.

-e Enables additions of a default route to the L3 network route table.

-l Leave hardware tables intact on exit.

-n Writes the proc table entry. zl3d writes 3/2 of it's

timeout value to /proc/net/sys/ipv4/route/route_expires. The Linux kernel uses this value as an expiration time for cache routes updated by zl3d.

-d <level> Sets the level of debugging output required by zl3d. The default level is one (1). Setting the debug level higher

produces more output. Four (4) is currently the maximum output level.

<iface…> The network interfaces on which zl3d should operate. These network interfaces must first be created by zconfig. zl3d does not operate with standard network interface cards. It only works on switch network interfaces created by zconfig. It uses the same syntax as zconfig.

OPERATIONS

zl3d manages the host route and network route tables located in the switch. Based on a trigger condition, zl3d reads the Linux FIB table and the Linux route cache. Each table entry is filtered by zl3d according to the following:

If an entry from the route cache is not a broadcast address or a local address, and zl3d is able to resolve the MAC address of the destination, then zl3d inserts the entry into the switch host route table.

If an entry in the Linux FIB table is a host entry and zl3d is able to resolve the MAC address of the destination host, then the entry is inserted into the switch host route table. If an entry from the FIB table is a gateway entry, is not local, and zl3d is able to resolve the MAC address of the gateway, then the entry is inserted into the switch network route table.

EXAMPLES

Normally, zl3d is run as a background task that continues throughout the life of the Layer 3 network.

In the following example, for the three interfaces specified, zl3d continuously monitors the Linux FIB and route cache tables looking for updates every three seconds. Entries in the switch host route table are checked for activity every 15 seconds and aged accordingly.

```
zl3d zhp1 zhp2 zhp3
```

SEE ALSO

zconfig

zlc

NAME

zlc – link and LED control

SYNOPSIS

```
zlc [-h <hostname>][-d <level>][-x] <port_list> <action> [on | off ]

zlc [-h <hostname>][-d <level>][-x] <action> [on | off |clear]

zlc [-h <hostname>][-d <level>][-x] [state|query]
```

DESCRIPTION

The zlc application sets the link speed and state of individual ports of the switch, or displays the current state. It can also turn on or off the extract LED or the internal fault LED.

OPTIONS

-h <hostname> Connect to remote host <hostname>.

-d <level> Set debug level to <level>

-x Expected query value. Creates no output, exit code only. If the port_list contains more than one port, returns the number of ports that match the option.

<port_list> Port or list of ports on which to take action. Port lists are supplied in zconfig syntax (e.g. zre1, zre2..4, etc.)

<action> Set link speed or state to up, down, auto, 1000fd, 1000hd, 100fd, 100hd, 10fd or 10hd. The interface must be down to change the port speed. Set intfault or extfault. Must supply <option>.

Use query to return present settings.

on | off Turn on or off the specified LED. Only valid for actions intfault, extfault or extract.

clear No longer globally control the specified LED

state Return the list of LEDs currently illuminated.

query Return the list of LEDs currently controlled globally.

EXAMPLES

In the following example, `zlc` forces the line speed of port 1 to 100 Full duplex. The interface must be down to change the speed. Assuming zre1 is part of interface `zhp0`,

```
ifconfig zhp0 down
zlc zre1 100fd
```

The external fault, internal fault, and ok LEDs can be set on a per port basis or *globally*. To set the external fault LED for a particular port,

```
zlc zre1 extfault on
```

To query the settings of a particular port,

```
zlc zre1 query
```

Global Settings

The external fault, internal fault, and extract LEDs are set as a logical OR of all the ports. The LEDs can also be set globally to on, off, or other. If globally set to on or off, the LED will not change when links go up or down ,or interfaces are configured. If set to other, the LED resumes its normal operation.

The next example globally turns on the Pull (extract) LED.

```
zlc extract on
```

Additional capabilities are also available by supplying an additional led action:

```
zlc <led_name> on
```

The `<led_name>` LED is turned on. The LED will not change when links go up or down or interfaces are configured. If other is used, the LED resumes its normal operation. <led_name> can be intfault, extfault, extract, or ok.

```
zlc query
zlc state
```

query lists the LEDs which have been set globally on or off. state shows which LEDs are on at the moment. All LEDs are shown, including the `clk` LED.

SEE ALSO

`ifconfig(8)`

zlmd

NAME

zlmd – monitor link changes or hot swap events.

SYNOPSIS

```
zlmd [-h <hostname>] [-b] [-d <level>] {-f <file>} |
<configuration>
```

DESCRIPTION

The zlmd application is intended to run as a daemon, waiting for a configured event to occur and then running the program configured for that event. The events monitored are changes in the link status of any of the ports of the switch, the start of removal of the switch from the back plane, or the cancellation of the removal before it actually takes place. The program can be a shell script that initiates appropriate actions to respond to the event.

OPTIONS

```
-h <host_name>  Connect to remote host <host_name>

-b    Do not background the zlmd process.

-d <level> Set debug level to <level>.

{-f <configuration_file>} | <configuration>

      Read configuration from <file>.  If file is a '+',
configuration is read from stdin.  Without the -f option, a
single line of input can precede the last flag.  (i.e.
<Configuration>)
```

CONFIGURATION SYNTAX

zlmd takes configuration data from standard input or from a file with the -f option. In either case, the configuration syntax is the same. The zlmd configuration data consists of a list of semicolon-delimited statements. Each statement specifies an event to monitor followed by a response action.

Configuration commands:

```
<port-list> = <program>
Run <program> when a fault occurs or clears on a port.

hotswap = <program>
Run <program> when a hot-swap extraction or insertion event
occurs.
```

```
<port-list>     A list of ports in the same forms supported by
zconfig, e.g. zre1,zre2 or zre10..14

<program>  Path to an executable program or script to be run
when the event occurs.  Note: An absolute path to <program> is
required. The program will be called with the following
parameters:

For Link Changes:

 <program> <ppa> <port> {external(0)|internal(1)} {off(0)|
on(1)}

For Hot-swap Events:

 <program> <ppa> {extraction(1)|insertion(2)}

Note: The <ppa> parameter is undefined and should be ignored.
```

EXAMPLES

In the following example, `zlmd` monitors ports 1 through 4 and runs a script called `prt_change` upon a link change event.

```
zlmd zre1..4=/usr/sbin/prt_change
```

Suppose port 2 were UP and you disconnected the cable, `zlmd` would call `prt_change` with the following parameters:

```
/usr/sbin/prt_change 0 2 0 1
```

where 0 is the ppa, 2 is the port, 0 is an external fault, 1 is ON.

SEE ALSO

`zconfig`

zlogrotate

NAME

`zlogrotate` – Rotates log files.

SYNOPSIS

```
zlogrotate [-b] [-t time] [-s segment size] [-n # of files] [-f file
to rotate]
```

DESCRIPTION

`zlogrotate` rotates the selected file every [time] seconds if the file is larger than [segment size]. It will keep only the number of files selected. `zlogrotate` is called from `/etc/init.d/rcS` by default with no parameters.

OPTIONS

```
-b    Do not background the process - i.e. run in foreground.

-t <time>  the time between logfile checks in seconds (default
60)

-s <size>  the targeted file segment size, in kilobytes
(default 256)

-n <# of files> The number of segments kept on the system
(default 4)

-f  <file> The file to rotate (default /var/log/messages)
```

EXAMPLES

To start `zlogrotate` with the default values,

```
zlogrotate
```

zmirror

NAME

zmirror - Set packet mirroring on an ingress or egress port.

SYNOPSIS

```
zmirror  -a | -t
zmirror  [-e] <from_list> <to_port>
```

DESCRIPTION

zmirror sets packet mirroring from a given set of ports to a given port. Turning on packet mirroring causes a copy of the packet to be sent to the *to* port. Any number of *from* ports can be mirrored to one *to* ports.

NOTE: There may be a significant performance impact when trying to mirror more bandwidth than is available on the *to* port.

After executing the following command, packets received on ports 1, 2 and 3 would be mirrored (copied and transmitted) to port 12. This mirroring would be in addition to any Layer 3 or Layer 2 switching.

```
zmirror zre1, zre2, zre3 zre12
```

To clear the current mirroring, use the -t option.

The -e option can be used to indicate that packets being sent on a given port should be copied to the *to* port. For example if the -e option is used as follows, the packets transmitted, as opposed to received, on ports 1, 2 or 3 would be mirrored to port 12.

```
zmirror -e zre1, zre2, zre3 zre12
```

The *to* port can also be the keyword cpu to indicate that packets should be forwarded to the on-board processor. The following example would mirror the contents of port 1, 2 or 3 to the on-board processor:

```
zmirror zre1, zre2, zre3 cpu
```

The *to* port can be a single port or the keyword cpu. The from port can be a list consisting of one or more ports. The *from* port cannot be the cpu. See the section on wildcards for discussion of from port lists.

`zmirror` is cumulative:

```
zmirror zre1, zre2, zre3 cpu
```

Is the same as:

```
zmirror zre1 cpu

zmirror zre2 cpu

zmirror zre3 cpu
```

Setting a different *to* port will overwrite the previous setting and direct previously mirrored ports to a new *to* port. Given the last setup the following will change port 1 traffic to be forwarded to port 10.

```
zmirror zre1 zre10
```

OPTIONS

```
-a    Display the current mirroring setup

-e    Set egress port mirroring for the specified from port

-t    Teardown or disable the mirroring
```

WILDCARDS

Wildcard characters can be included to simplify the process of creating larger, more complex configurations. Wild card characters for `zconfig` include:

```
,    (comma)      Use for creating lists

..   (dot-dot)    Specifies an inclusive range
```

Below are some examples for the correct usage of the comma (,) and dot-dot (..). Each line below produces the same results:

```
zre1, zre2, zre3, zre4

zre1..4

zre1, zre2..4

zre1..2, zre3..4
```

SEE ALSO

`tcpdump(1M)`

zmnt

NAME

zmnt – Expands the read/write files onto the RAM disk.

SYNOPSIS

```
zmnt [-c] <directory>

zmnt [-c] -t <file>

zmnt [-c] –l
```

DESCRIPTION

zmnt expands files from flash onto the RAM disk that have been previously saved with zsync. The init process runs zmnt to expand the files in flash onto RAM file system. The user may use zmnt to expand the files at anytime and may place them in any directory. For example,

```
zmnt /tmp
```

will expand the files under the directory /tmp.

Booting the kernel with -i instructs the init process to skip the zmnt stage After booting in this way, zmnt can be used for correcting a problem file in the read-write file system.

The -t option can be used to save the configuration of a switch to a tar file. A tar file can be copied to another switch and saved with zsync -t. As a result, the configuration of a switch may be cloned to other switches.

The -c option is used to mount the custom overlay. See zsync for a description of custom verses dynamic overlay.

OPTIONS

```
-c    Read saved files from the custom overlay

-t <file>
Save the overlay into the specified <file> in tar format.

<directory>     The directory under which the overlay files
are expanded, or the file to which the tar image is saved.

-l    List files in selected overlay, do not unpack.
```

EXAMPLES

In the following example, `zmnt` the current overlay into a tar file called overlay.tar

```
zmnt –t overlay.tar
```

The resulting tar file can now be saved on a different host as a snapshot of the overlay at that point in time. Use `zsync` to restore the overlay on the switch:

```
zsync –t overlay.tar
```

The restored overlay will be used upon the next reboot.

SEE ALSO

`zsync`

zpeer

NAME

zpeer – Application for High Availability communication between the Fabric and Data switches.

SYNOPSIS

```
zpeer [-d <level>] local|peer <command> <value>|query

zpeer [-d <level>][-a][-r]
```

DESCRIPTION

zpeer is used to pass bidirectional High Availability(HA) state and priority information between the base and fabric switches in the Ethernet Switch Blade. zpeer uses the concept of local and peer information. The local information is written, and the peer information is read. As an example:

On the base switch:

```
zpeer local priority 203
```

On the fabric switch the following command would return 203:

```
zpeer peer priority query
```

The communication is bidirectional so the example above can be reversed allowing the fabric switch to pass state and priority information to the base switch.

NOTE: Local information can also be read as confirmation and for debugging purposes.

zpeer is part of the HA software suite. It is called as part of the scripts that are generated by the zspconfig application. With the exception of querying information for debugging and validation, the zpeer application would not need to be executed by the user. Following is a quick overview of the values communicated between switches. See documentation on HA and zspconfig for better understanding of how zpeer fits in with the HA software suite.

Following is an example of setting the state to “backup”:

zpeer local state backup

Possible states are:

unhealthy	Set by hardware at power up or at system reboot. Set by software when the HA software suite is stopped. Indicates that the peer is not properly functioning
healthy	Set by software when HA is started. This state is never

	displayed by query, but must be set at initialization. After setting the healthy state, the query will return the backup state.
backup	Used to reflect the backup state of vrrpd
master	Used to reflect the master state of vrrpd

The priority value is a value between 0 and 255. In the HA suite, the value is set to 254 minus the number of ports that are link down.

The state or priority value for the local or peer can be displayed with the query command. The following will query the state of the peer switch:

```
zpeer peer state query
```

The output from the above command during the boot process would be “unhealthy”

The `-a` option can be used to display a complete listing of all state and priority information and internal information that can be used for debugging. Here is example output from the `-a` option.

```
                       Local/Write      Peer/Read
priority                 203        231
state                    master           backup

data                      2|cb             2|e7
position byte|bit         2|8              2|0
status                    50(ACK)     0()
```

The priority and state rows are the same values returned by the query command. The information in the data, position and status rows are internal debugging information that is useful to support engineers when diagnosing problems in the field.

The `-r` option should not be used while HA is running. It can cause loss of coordination between the two switch planes. The `-r` option will reset all internal communication values, and possibly require the peer to be reset also.

OPTIONS

```
   -d    set debug level to <level>

   -a    Display complete status of zpeer

   -r    Reset all values in the zpeer communication.  Can cause
         loss of communication with the peer requiring the peer to
```

```
        be also reset.
```

SEE ALSO

```
zspconfig
```

zqosd

NAME

zqosd – monitors tc(8) commands to implement classification filters and queuing disciplines in hardware.

SYNOPSIS

```
zqosd [-d <level>] [-p <port>] [-f] [-l] [-i <pid>] [-o <pid>]
```

DESCRIPTION

zqosd monitors commands entered by tc which set up queuing disciplines and classification filters for managing traffic in the switch. It supports a variety of queuing disciplines which allow distributing available bandwidth at each output port of the switch among different classes of traffic as well as selecting which packets to drop when bandwidth limits are exceeded.

zqosd does not directly set up the hardware. It prepares messages describing the queuing disciplines and filters and sends them to a hardware specific daemon, ztmd. ztmd should be started before zqosd. Both programs normally run as background processes.

OPTIONS

```
-d <level> Set the level of diagnostic information logged.
<level> may be 0-4; higher levels produce more output.

- p <port> Use <port> as the multicast listening port for
communication with ztmd.  Default is 2345.

-f   Run zqosd in the foreground.  Without this option, it is
run as a daemon.

-l   Log diagnostic output to /var/log/zqosd.log

-i <pid>   Set the pid for this process.

-o <pid>   Set the pid of the destination process (ztmd)
```

EXAMPLES

Start the traffic management daemon, ztmd, then start zqosd to monitor tc output. Both daemons are run as background processes and log their messages.

```
ztmd –l

zqosd -l
```

SEE ALSO

ztmd, tc(8), zfilterd

zrc

NAME

zrc - Packet rate control

SYNOPSIS

```
zrc  -b | -m | -d | -t | -a [-p <port>] [-v <vlan>] [-g
<group>] [-M <mac_addr>] [-T <timeout>] [-D <level>] <rate>
```

DESCRIPTION

zrc sets rate control on Broadcast, Multicast and/or Destination Lookup Failure (DLF) packets. The rate is measured in the number of packets per time period. If the number of packets received of the specified type exceeds the specified rate limit, packets are discarded at the ingress port.

OPTIONS

```
-b    Enable rate control for Broadcast packets

-m    Enable rate control for Multicast packets

-d    Enable rate control for DLF packets

-t    Teardown or disable all rate control

-a    Display the current rate control settings

-p <port>  Enable rate control on this <port>

-T <timeout>    Set time period to <timeout> milliseconds.
Default is 1000 (one second).

-D <level> Set debugging output to <level> when running the
program.

<rate_limit>    The number of packets per time period above
which Broadcasts, Multicasts and/or DLFs will be discarded.
Valid rate limits are any number between 0 and 262143.
```

SEE ALSO

ztats

zreg

NAME

zreg - Read and write registers and tables on the OpenArchitect switch switching hardware.

SYNOPSIS

```
zreg [-p <ppa>] [-w] [-i <index>] [-t <index>] [-k] [-h
<hostname>] [-d <level>] [-r 10] <reg>
```

DESCRIPTION

zreg allows a user to read and write direct and indirect registers and tables on the resident switch chip. zreg is commonly used for debug, or for prototyping when creating applications that control the OpenArchitect switch. It is also useful when put into shell scripts for displaying hardware status or statistics. Although the -t option allows tables to be displayed, one might find the formatted output of the table functions more useful. See zal.

OPTIONS

-p <ppa> Specify the Physical Point of Attachment (PPA). Each OpenArchitect switch that is controlled by the CPU on which zreg is running is a unique PPA. If there is only one OpenArchitect switch, as would be the case when zreg is running on the embedded processor the PPA would be 0. The default PPA is 0.

-w Causes zreg to write to the register or table. Data to be written is read from standard input.

-i <index> Causes zreg to access at the indexed register specified by <reg>. See OPERANDS for usage of <reg> with indexed registers. The <index> parameter is used to determine which entry i

-t <index> Causes zreg to access the memory specified by <reg>. The <index> parameter is used as the index into the specified table. Only content addressable memories are accessed using the –t option. All other tables and memories are accessed with the –i option.

-k Causes zreg to access the memory specified by <reg>. The entry accessed is determined using the data from standard input as the search key. Enter 0 for fields that are not part of the search key.

-h <hostname> Specify the <hostname> to configure. By

default zreg configures the OpenArchitect switch that is locally connected (i.e., the one that is on the local PCI bus).

-r 10 Sets numeric radix for registers to 10. Default is 16.

-d <level> Set the level of debugging output produced by zreg. The default level is 1. Setting the debug level higher produces more output. The maximum level of output is currently 4.

OPERANDS

TBD

EXAMPLES

There are three types of accesses performed by zreg; scalar register, indexed register, and table. For each of theses access types, values can be read or written. Content addressable memory register access is the default. The following is an example of reading the CONFIG Register:

```
zreg 1
```

When running zreg on the embedded processor of the OpenArchitect switch, the <ppa> is always 0, since the embedded CPU processor only controls the directly attached switch chip.

To write a value to a register the -w flag is used and the data is read from standard input. The following example writes 0x10003c to the Aging Time Register:

```
echo 0x10003c | zreg -i 0 131 -w -p 0
echo 0x10003c | zreg -i 0 131 -w -p 1
echo 0x10003c | zreg -i 0 131 -w -p 2
echo 0x10003c | zreg -i 0 131 -w -p 3
```

If the zreg command is typed at the prompt, it waits for input from the user. You may also use File I/O or shell scripts. The following example reads the MAC Packet Length Register for port 7:

```
zreg -i 7 2
```

SEE ALSO

zal, ztats

zrld

NAME

zrld – ZNYX redirector daemon

SYNOPSIS

```
zrld [-d <level>] [-p <port>] [-f]
```

DESCRIPTION

zrld is used for remote management of OA/HA applications. OA/HA applications capable of remote management include zlc, ztats, zlmd.

zrld only allows requests from hosts listed in /etc/rcZ.d/zrld_trusted_hosts.

OPTIONS

```
-d <level> Set debug level to <level>

-p <port>  Specifies TCP port to listen on. Default port is
7000.

-f         Run the daemon in the foreground
```

EXAMPLES

In the following example, zrld starts a background task that listens on the default port 7000 for incoming TCP requests and passes along the request to the OA/HA application,

```
zrld
```

Once started, you can issue supported commands to the host running zrld from a remote host. For example, if the host running zrld had an IP address of 10.0.0.43, you could use zlc to remotely query the status of ports 1 through 5. Remember, the IP address of the switch you are on must be listed in /etc/rcZ.d/zrld_trusted_hosts on the switch running zrld.

```
zlc –h 10.0.0.43 zre1..5 query
```

SEE ALSO

zlc, zlmd, ztats

zsnoopd

NAME

zsnoopd - IGMP Snooping daemon for the OpenArchitect switch.

SYNOPSIS

```
zsnoopd [-d <level>] [-f] [-h <hostname>] [-p <ppa>]
[-r <sec>] [-t <sec>] [-u <sec>] [-v <vlan_id>]
```

DESCRIPTION

zsnoopd is run after the network interfaces are created and initialized with zconfig, and started with ifconfig(1M). zsnoopd starts a background task that monitors incoming IGMP traffic in order to learn which hosts in a VLAN are listening to which IP multicast addresses. zsnoopd updates the multicast table in silicon with this information, so that IP multicast traffic is forwarded only to the ports in a VLAN to which listening hosts are attached. This optimizes packet flow through the switch. Traffic on all VLANs is monitored by default. IGMP snooping can be restricted to specific VLANs using the −v option. The background task started by zsnoopd continues throughout the life of the Layer 2 network.

zsnoopd manages the switch multicast table (MARL). Based on monitored IGMP traffic, zsnoopd creates or updates an entry in the MARL. The key to each MARL entry is a source Ethernet multicast address combined with a VLAN ID. Two port bitmaps are maintained: one that identifies the untagged members of the VLAN, and one which identifies which ports of the VLAN have listening hosts attached.

When the maximum number of entries in the MARL is reached, zsnoopd deletes a random entry prior to adding the next entry.

Traffic from IP multicast addresses not found in the multicast table is forwarded to all ports within a VLAN. Traffic from reserved IP multicast addresses (224.0.0.X) is forwarded on all ports within a VLAN.

To operate correctly, traffic from unregistered IP multicast addresses should be forwarded on all ports in a VLAN. To do this, the multicast port filtering mode must be set to FORWARD_UNREGISTERED. See zconfig.

Neither zgmrpd nor zgvrpd can run concurrently with zsnoopd.

OPTIONS

```
-d <level> Sets the level of debugging output required by
zsnoopd. The default level is zero (0). Setting the debug
level higher produces more output. Four (4) is currently the
maximum output level.
```

```
-f   Run zsnoopd in foreground. Default is to run it in
background.

-h <hostname>   Connect to remote host <hostname>.

-p <ppa>   Start zsnoopd on switch <ppa>. Default is 0.

-r <sec>   Time to wait, in seconds, before removing a port
with no router multicast traffic. Default is 260 seconds.

-t <sec>   Time to wait, in seconds, before removing a port
with no host multicast traffic. Default is 260 seconds.

-u <sec>   Time to wait, in seconds, before checking port
timeouts.

-v <vlan_id>    Enable zsnoopd for VLAN <vlan_id>. Default is
to enable zsnoopd on all VLANs. This option may be entered
more than once.
```

EXAMPLES

In the following example, `zsnoopd` starts a background task that monitors incoming IGMP packets and updates the Multicast Table (MARL) accordingly. This background task continues throughout the life of the Layer 2 network.

```
zsnoopd
```

Once you run `zsnoopd`, use `zmarl` to display the contents of the MARL. `zsnoopd` deletes all entries in the MARL when starting up, and when shutting down. Manual changes to the MARL are not recommended while `zsnoopd` is running

SEE ALSO

`zconfig, zgmrpd`

zspconfig

NAME

zspconfig - configure and start surviving partner

SYNOPSIS

```
zspconfig [-d <level>] [-p <directory_path>] [-u
<dhcp_interface>] [-c <dhclient.conf>] [-t <timeout>] [-s]
[-v] -f <file>
```

DESCRIPTION

zspconfig is used to configure and start the Surviving Partner software. With the -f option a configuration file is provided that completely describes the network setup and desired behavior of all of the switches participating in the Surviving Partner. With the -u option the interface on which to run dhclient to retrieve a configuration file must be provided. The configuration file format retrieved by a -u is identical to that supplied with -f. It is envisioned that the -f option is used for initial configuration, and all subordinate and replacement switches run zspconfig with the -u option. The -v option prints the current version of zspconfig and performs no actions.

OPTIONS

```
-d <level> Set the debug level.  The default debug level is 1.
The higher the level, the more debugging output is produced.
Debugging output is sent to the console.

-p <directory_path>
Set the directory path for where zspconfig places the scripts
it generates.  The default location is
/etc/rcZ.d/surviving_partner.

-u < dhcp_interface>
Come up as an unconfigured slave. Use the specified
<dhcp_interface> to retrieve the configuration. User
confirmation is not required unless the –s option is also
used.

-c <dhclient.conf>
Use file <dhclient.conf> as the configuration file to dhclient
when retrieving configuration information. If  -c is not used,
a default configuration file is created and used. Only valid
with the –u option.
```

```
-t <timeout>    Time to wait in seconds before giving up on
finding a Surviving Partner to retrieve configuration
information from. Only valid with the –u option.

-s    Do not ask for confirmation. Run from a script.

-v    Prints the current version of zspconfig.

-f <file>  The provided <file> is used as input to configure
the Surviving Partner.  See the next section on CONFIGURATION
FILE for the syntax of the configuration file.
```

CONFIGURATION FILE

The configuration file contains commands for controlling the Surviving Partner setup. Commands are single lines end -delimited with a semicolon. Comments, spaces and new lines are ignored. Comments begin with the # character and include characters through the next new line. Comments may be placed on the same line as a command after the semicolon.

All configurations must include the VLAN configuration first by use of `zconfig` commands. `zconfig` commands can be put in the configuration file and will be passed directly to the `zconfig` application. `zconfig` commands start with the keyword `zconfig` and are of the same format as described in the `zconfig` manual page. Here is an example of `zconfig` commands in a `zspconfig` configuration file.

```
zconfig zhp0: vlan1 = zre1..4;

zconfig zhp1: vlan2 = zre5..8;

zconfig zhp2: vlan100 = zre14;
```

In the above example, three VLANs are created: `zhp0` and `zhp1` will be used as connections to high availability nodes; `zhp2` will be used as the inter-connect between two Surviving Partner switches to run the VRRP heartbeat. All VLANs must be created before other zspconfig commands may operate on them.

The next section of a `zspconfig` configuration file sets up the IP addresses of the created VLANs. There are two types of addresses in a Surviving Partner setup: *Physical Addresses*, and *Virtual Addresses*. The Virtual Addresses are those that VRRP manages and moves to the current Master switch. The Physical Addresses are the real addresses of the switch, and are used for management only. Physical Addresses are setup using the `sibling_addresses` command. Virtual addresses are setup using the `virtual_address` command. The sibling addresses name comes from the fact that we are setting up the addresses for all of the siblings in the Surviving Partner group. So if we have two Surviving Partner switches, the `sibling_addresses` statement might look like this:

```
sibling_addresses: zhp0 = 10.0.0.30, 10.0.0.31;
sibling_addresses: zhp1 = 11.0.0.30, 11.0.0.31;
sibling_addresses: zhp100 = 100.0.0.30, 100.0.0.31;
```

A sibling_addresses statement is required for each VLAN created with the `zconfig` commands. The two addresses in the list indicate there are two switches in the Surviving Partner group. The first address 10.0.0.30 and 11.0.0.30 are assigned to the switch on which the configuration is being run. The remaining addresses are distributed to the switches that run `zspconfig -u` on a first come, first serve basis.

The `sibling_addresses` command may also take a `netmask` operand similar to that given to `ifconfig`. For example:

```
sibling_addresses: zhp0 = 10.0.0.30, 10.0.0.31 netmask
 255.255.255.0;

sibling_addresses: zhp1 = 11.0.0.30, 11.0.0.31 netmask
 255.255.255.0;
```

Virtual addresses should be setup for all VLANs that connect to High Availability nodes. Usually this would include all VLANs except the interconnect VLAN or VLANs connected to upstream routers. It is possible that a setup would have VLANs that are used for management only. Virtual addresses are setup as follows:

```
virtual_address: zhp0 = 10.0.0.43 netmask 255.255.255.0;
virtual_address: zhp1 = 11.0.0.42 netmask 255.255.255.0;
```

Only a single address per VLAN is provided because this single address will move with the current Master switch, and the netmask must be the same as that provided in the `sibling_addresses` statement.

The last required section for the configuration is description of the ports. Particularly we need to specify one of the following for all of the ports participating in the high availability setup. The possible port types are:

interconnect - Ports connected between groups of Surviving Partner switches. VRRP heartbeat messages are sent on the interconnect ports.

Crossconnect - Crossconnect ports are ports that are connected to other Surviving Partner switches, that are not part of this Surviving Partner group. Crossconnect ports behave differently then bonding ports. The links are not brought down temporarily, and VRRP runs with the native MAC addresses to avoid MAC address duplication with the other VRRP group.

RAINLink - Ports connected to rain link or bonding driver nodes. These ports contain virtual addresses managed by VRRP. And during a failover event, the links are toggled down to force failover to the Master switch.

Route - Ports connected to upstream routers. VRRP does not manage virtual IP addresses for these links. Routing protocols must be used to instruct up stream routers of a different path to get to the VRRP managed networks.

monitor_only - Ports that are monitored but do not have a virtual address managed on them. They will not have their links brought down temporarily during a failover scenario. These ports are only monitored. If a problem occurs on this type of link it will cause a failover scenario.

configure_only - Ports are configured as per the `zconfig` commands, but do not participate in the high availability network. Problems on these links will not cause a switch failover.

NOTE: The `zhp` specified for interconnect is important, and will be the `zhp` interface/VLAN where `zspconfig`/HA on the the master will start the DHCP daemon. Zre51 on the slave swtiches should be configured up into this same VLAN so that `zspconfig -u` can connect to the master.

Each port that is setup in a VLAN by the `zconfig` commands must have its port type specified. The port type is specified on a physical port bases. That is on a `zre` basis, but `zhp` names can be used as a quick way to setup the port type for all ports that are a member of that VLAN. It is possible to make a port a member of more then one VLAN. That is a `zre` can be a member of more then one `zhp`. In such cases, configuring the `zhps` as different port types would cause a conflict, and will not work. To handle this setup the individual `zre` commands would be used to setup the port types. Here is an example of setting up the port types as a continuation of our current configuration:

```
interconnect:   zhp2; # Could also use zre14

rain link: zhp0, zhp1;     # Could also use zhp0..1,
           # or list the zres
```

The ".." wild card is supported as in `zconfig` to indicate a range of numbers. The comma is used to indicate a list. The `zres` that are part of the `zhp` could also be used. Here is a more complex setup. The `zconfig` commands are also shown to understand the VLAN setup:

```
zconfig zhp0: vlan1 = zre1..4, zre23;
zconfig zhp1: vlan2 = zre5..8, zre23;
zconfig zhp100: vlan100 = zre23;

zconfig zhp0: vlan1 = zre1..4;
zconfig zhp1: vlan2 = zre5..8;
zconfig zhp2: vlan100 = zre23;



#  sibling and virtual address setup omitted

interconnect:   zhp100;
rain link: zre1..8;   # Use zre definition to
                      # exclude zre23
```

If `zhp0` and `zhp100` are setup as different port types, there would be a conflict for port `zre23`. In the particular example above, the `zre23` is shared. It is used to pass VRRP interconnect traffic and as a means to pass VLAN 1 and 2 traffic between switches. Since `zre23` is an

interconnect, it is not a bonding driver enabled port, and therefore should be setup as an interconnect port type. To accomplish this, the zre ports are listed to avoid conflicting port types.

Note that a single line cannot contain both zhp and zre definitions. Therefore

```
rain link: zhp1, zre1..4
```

does not work and the definition zre1..8 is equivalent.

Optional zspconfig commands are listed below.

```
vrrp_msg_rate:  100;  # Time in milliseconds.
                      # Default is 100 milliseconds
```

The message rate is the interval between VRRP messages sent over the interconnect link. The time given is in milliseconds. It takes the lack of 3 VRRP messages for the Backup to assume the role as Master. It is recommended with faster message rates to increase the default priority to 254. The higher priority will decrease the latency of the failover.

```
vrrp_def_priority:    254;  # default is 100.
                            Value from 1 to 254
```

The default virtual MAC address for VRRP is 00:00:5E:00:01:<vid>, where <vid> the virtual router ID. Using this virtual address is problematic in network environments where multiple VRRP instances might be running that are using the same <vid>. To overcome this problem, zspconfig, uses a default MAC address derived from the physical address of the switch on which it is running. For the slave switch, the vrrp_virtual_mac_addr command is used to set the MAC address to the same as the Master. This statement is typically not used within the Master switch's configuration. It is used in the zspconfig generated Slave switch configuration. And is retrieved by the Slave switch with zspconfig using the –u option. If in doubt, don't use this command.

```
vrrp_virtual_mac_addr: 00:01:02:03:04:05
```

There are three failover_modes supported; switch, vlan and port. For switch failover, if any managed link fails, the entire switch is failed over to the backup switch. In vlan failover, if a link fails in a VLAN, only the links associated with that VLAN are failed over. In *port* failover, only the port that fails is moved to the backup switch. For both vlan and port failover, the interconnect link will need to be used to maintain connectivity between ports that have failed over and those that have not. For vlan and port failover modes, the interconnect link must be an in-band port, and must be included in the managed VLANs running with VLAN tagging on.

```
failover_mode:  switch;
failover_mode:  vlan;
failover_mode:  port;
```

Additional startup scripts may be included in the configuration using the start_script command. The files in the start_script command will be placed in a location for `tftp` transfer to sibling switches that initialize using the `-u` option. A common use of the start_script command might be to propagate *gated* configurations to all members of the Surviving Partner group. Absolute path names must be used. Using multiple commands allows inclusion of multiple scripts. For example:

```
start_script: /etc/rcZ.d/S75gated;
start_script: /etc/rcZ.d/S80static_routes;
```

The `vrrpd_script` command allows a user defined script to be run when `vrrpd` changes state. This script is called at the end of the `zspconfig` created vrrpd.script. See vrrpd `-s` for a description of when the scripts are called. `zspconfig` sets up vrrpd to call vrrpd.script. The `vrrpd_script` command in `zspconfig` places a call to the user-defined script at the end of `vrrpd.script` file. The following example would call the `my_vrrpd_script` each time vrrpd calls its `-s` provided script:

```
vrrpd_script:  /etc/rcZ.d/surviving_partner/my_vrrpd_script;
```

NOTE: The `my_vrrpd_script` is not called from a different process thread. Therefore if `my_vrrpd_script` crashes or has long delays, it will crash the `vrrpd`, or cause delays in the Surviving Partner failover. To protect against this, write the script to launch a second script in a background shell. The advantage to calling the user provided script in the same process thread is that it gives synchronized control over the failover process for those who want it.

OUTPUT FILES

The output of `zspconfig` is a set of configuration and script files. The configuration files configure `vrrpd` and `zlmd` daemons. The `vrrpd` and `zlmd` daemons combined with the script files run the Surviving Partner. This is a list of all configuration and script files:

```
/etc/rcZ.d/S70Surviving_partner
The main startup script that starts the Surviving Partner by
running  zconfig, ifconfig, zlmd and vrrpd.  zspconfig prompts
the user to run this script.  This file can be saved with
zsync to automatically start the Surviving Partner at switch
boot.

/etc/rcZ.d/surviving_partner/vrrpd.conf
Configuration script for the VRRP daemon.  This configuration
is used when the S70Surviving_partner script launches vrrpd.
There is a line in this file for each router address vrrpd
will manage.  Or stated another way, each virtual_address
command in the zspconfig configuration file results in a line
in vrrpd.conf.

/tftpboot/zsp.conf<n>
zspconfig configuration file that contains the configuration
of the sibling backup switches.  The <n> is used to
```

distinguish potentially more than one backup switch. This configuration file is placed in /tftpboot, and is retrieved via DHCP by a replacement switch on boot up.

/etc/rcZ.d/surviving_partner/dhcpd.conf
Configuration script used by dhcpd when the switch becomes master. dhcpd is used to serve replacement switches their configuration scripts. Namely a zsp_DC.conf file that can be input to the zspconfig with the -u flag.

/etc/rcZ.d/surviving_partner/dhclient.conf
If zspconfig is executed with the -u flag, a dhclient.conf file is created, and then dhclient is used to retrieve a zspconfig configuration file from the /tftpboot area of the Master switch.

/etc/rcZ.d/surviving_partner/vrrpd.script
Runtime script that executes each time the vrrpd changes state. This script starts and stops dhcpd, and toggles down bonding driver/rain link ports to force the nodes to a new Master switch.

/etc/rcZ.d/surviving_partner/zlmd.script
Runtime script executed by zlmd when a link goes up or down. This script modifies the priority of vrrpd, which in turn may cause the VRRP Master to move from one sibling switch to another.

SEE ALSO

zconfig, ifconfig, vrrpd, dhclient, dhcpd

zstack

NAME

zstack - Configures the OpenArchitect switch stacking.

SYNOPSIS

```
zstack [-h <host_name>] [-d <level>] [-a] [-t] [{-f <file>} |
<configuration>]
```

DESCRIPTION

zstack combines multiple switch fabric chips into a single virtual switch. zstack must be run before any other switch configuration. Specifically it must be run before zconfig. zstack is typically run from an S20stack script prior to the S50xxx scripts. zstack currently only supports directly connected switch chips as are present on the Ethernet Switch Blade. Directly connected means that the local CPU can directly access and control the switch fabric chips being stacked. zstack does not yet support network based stacking where there are separate boards with separate CPUs controlling the switch fabric chips.

OPTIONS

-h <hostname> Specifies the remote hostname to configure. By default, zstack configures stacking on the local OpenArchitect switch. This option should only be used for displaying the configuration, if at all.

-d <level> Sets the level of debugging output produced by zstack. The default level is 1. Setting the debug level higher produces more output. The maximum output level is currently four (4).

-a Displays the current stacking configuration of the switch.

-t Tears down the entire switch stacking configuration.

{-f <file>} | <configuration>
Gets configuration information from the specified file. A <file> name of '+' reads configuration data from standard input. If the -f flag is not used, a single line of configuration data can be entered as parameters to zstack.

CONFIGURATION SYNTAX

zstack takes configuration data from standard input or from a file with the -f option. In either case, the configuration syntax is the same. The zstack configuration data consists of a list of

semicolon-delimited statements. Each statement specifies an action to take on a stack. A stack is a group of ports on a single switch fabric chip. Actions include stack creation, stack port association, stack configuration and stack control.

Comments, spaces and new lines are ignored. Comments begin with the # character and include characters through the next new line.

Stack Creation

The first step in creating a stack is to define its location. Each stack is assigned a unique small integer by the user. On the Ethernet Switch Blade this integer must be a value from 0 to 31. The location is defined with two values; a Physical Point of Attachment (ppa) and a network location. The ppa is defined by the keyword "ppa" followed by an integer value. The integer value is a 0 based contiguous value representing the physical switch fabric chip as it was discovered by the Linux operating system. In the case of the Ethernet Switch Blade there are two chips directly controlled. The network location specifies an IP address of the CPU that controls the physical switch fabric chips. If the CPU that is running `zstack` controls the physical switch fabric chip, the key word "local" is used in place of the IP address. Currently only "local" CPU control is supported.

Stack creation example for a Ethernet Switch Blade:

```
stack0: ppa0 local;

stack1: ppa1 local;
```

The above statements indicate that there are two switch fabric chips that are controlled by the local CPU.

Stack Port Association

After stack creation, the physical ports must be associated with a virtual port name. One might think of this as mapping the ports from their physical association to a virtual name. The physical port numbers are usually 0 based, but are dependent on how the ports are physically configured in the switch fabric silicon and how those ports are labeled at the physical connector. At a minimum the port association is used to move the ports of a second, third, or more switch silicon chip to a different virtual port name then the others. In this way, the ports can be built into a unique linear port list.

Stack port association syntax:

```
stack<N>: <zre_list> = <zre_list>;
```

The port association statement begins with the stack and number representing the group of ports being mapped. The stack must be previously created with a stack creation command. After the semicolon are two `zre_lists` separated by an equal sign. The first is the list of virtual port names, the second is the physical port names. The assignment is done in order, and there must be

an equal number of ports in each list. Wild cards may be used in the `zre_lists`. See below.

Stack port association syntax for a Ethernet Switch Blade:

```
stack0: zre0..11 = zre0..11;

stack1: zre12..23 = zre0..11;
```

The first statement above configures the first switch silicon chip, represented by stack0, to have no translation between its physical port numbering and its virtual port numbering.

NOTE: The statement must be made even if the mapping is one-to-one.

The second statement above configures the second switch silicon chip to have its physical ports 0 through 11 map to virtual ports 12 through 23. The mapping is done in a linear fashion. `zre0` maps to `zre12`. `zre1` maps to `zre1` and so on.

Stack Configuration Statements

After stack creation and port association, the configuration of the stack must be defined. The stack configuration provides the network map of how inter-switch fabric communication is performed. It specifies which physical port or should be used to communicate with a different group of stacked ports. The syntax is as follows:

```
stack<N>: stack<M> = zre<n>;
```

The above syntax indicates that stack N should use `zre` n to access stack M. The `zre` value n is a physical port number as seen by Stack N. It is not a virtual port number as mapped by a port association command. Multiple configuration statements for Stack N can be used to indicate how to get to other stacks.

NOTE: `stack<M>` can be a list of comma delimited or range of stacks as described below in the section on wild cards.

Stack port association example for a Ethernet Switch Blade:

```
stack0: stack1 = zre12;

stack1: stack0 = zre12;
```

The above example indicates that stack0 is connected to stack1 through the port 12 and stack1 is connected to stack0 through port 12. `Zre12` on the Ethernet Switch Blade switch fabric chips is the HIGIG port and are directly connected between the two devices.

Stack Control Statements

Finally after creating the stack, associating the ports, and setting the stack configuration, the stack can be enabled using one of the Stack Control statements. The following stack control statements

are supported.

```
enable;
```

The enable statement turns on stacking that has been previously configured. This statement cannot be made until configuration is complete.

```
disable;
```

The disable statement turns off stacking. Before disabling stacking, all Ethernet Switch Blade daemons must be stopped, and the VLAN configurations must be torn down using `zconfig`.

EXAMPLES

```
zstack stack0: ppa0 local

zstack stack1: ppa1 local

zstack stack0: zre0..23, zre48..49 = zre0..25

zstack stack1: zre24..47, zre50..51 = zre0..25

zstack stack0: trunk0 = zre26..27

zstack stack1: trunk0 = zre26..27

zstack stack0: stack1 = trunk0;

zstack stack1: stack0 = trunk0;

zstack enable
```

WILDCARDS

Wild card characters can be included to simplify the process of creating larger, more complex configurations. Wild card characters for `zconfig` include:

```
,    (comma)      Use for creating lists

..   (dot-dot)    Specifies an inclusive range
```

Below are some examples for the correct usage of the comma (,) and dot-dot (..). Each line below produces the same results:

```
stack0: zre4..7 = zre0, zre1, zre2, zre3;

stack0: zre4, zre5..7 = zre0..3;

stack0: zre4..7 = zre0, zre1..3;

stack0: zre4, zre5..7 = zre0..1, zre2..3;
```

The stack may also be in list form in the Stack Configuration command in similar fashion to the

`zre lists`. Example of stack0..3 representing stacks 0, 1, 2 and 3.

SEE ALSO

`zconfig`

ztats

NAME

ztats – Display statistics and information about switch

SYNOPSIS

```
ztats  [-d <level>] [-i <unit>] | [-m <port>] |
[-v <vlan id>] | [-t <tgid>] | [-v]
```

DESCRIPTION

ztats displays MIB counters for a selected physical port, trunk group or VLAN. It can also display information about the configuration of the switch and bridge to the PCI bus or the Vital Product Data memory. All output is formatted.

OPTIONS

-m <port> MIB statistics for specified <port>

-v <vlan id> MIB statistics for specified <vlan id>

-i <unit> Information for specified <unit>:

0 is BCM56504 ports 0-23, 48, 49

1 is BCM56504 ports 24-47, 50, 51

-d <level> Set debug level to <level>

-t <tgid> MAC layer statistics for all ports in trunk <tgid>.

-v Vital Product Data (not currently supported in Ethernet Switch Blade)

EXAMPLES

To display statistics for a particular port on the switch, such as port 0

```
ztats –m 0
```

SEE ALSO

zreg, zal

zsync

NAME

zsync – Saves changes to the flash.

SYNOPSIS

```
zsync [-c][-f][<dir_or_file>]

zsync [-c][-f][-t <file>]

zsync [-c][-f][-z]

zsync [-c][-l]
```

DESCRIPTION

zsync is used to save a snapshot of the current file system to flash ROM. By default, zsync creates a compressed tar image of the files that have changed and saves the image in the flash ROM. The saved image is expanded on reboot. The saved compressed tar image is called an "overlay".

If a directory parameter is given to zsync, the contents of the directory are saved instead of searching for updated files. The specific purpose of the <directory> parameter is for saving files that have been mounted with zmnt. Using the -t option allows a tar image created by zmnt -t to be saved.

To correct a corrupted file that is saved to flash ROM with zsync, first reboot with the -i option (*see Switch Maintenance*). Use zmnt to put the corrupted file in the /mnt directory, open and correct the file, then zsync to the /mnt directory to save your changes and reboot.

There are two overlay areas: *dynamic* and *custom*. The dynamic overlay is where the switch's current configuration is stored. It will boot with a simple reboot command. The custom overlay is where the customization to the standard software is stored. It is used to create new, customer-specific default configurations that differ from the generic configuration. The intent of the custom overlay is to make it possible for customers to customize the switch for their end users. To return to the custom overlay, (that is, default configuration) use the reboot -i option. The custom overlay is written by using the -c option.

The -z option zeros the overlay area, returning the switch to the factory configuration.

Specific files or directories can be excluded from saving to flash by zsync by including an entry in /etc/exclude. Likewise, existing entries in /etc/exclude such as /tmp can be removed in order to save those files to flash with zsync.

OPTIONS

```
-c    Save files to the custom overlay
```

```
-t <file>  Read files to be saved from a tar file.

-z    Zero the overlay area.

-f    Do not confirm with user and do not warn if saving
failed. Exit code can be examined to determine success or
failure.

<dir_or_file>   Save only the named file, or save the named
directory to the overlay. Contents of directories must be
created with zmnt.

-l    List files that would be written.  Do not flash.
```

EXAMPLES

To `zsync` only the hosts file:

```
cd /etc

zsync hosts
```

If you previously created a snapshot of an overlay to a tar file using `zmnt`,

```
zmnt –t overlay.tar
```

You can use `zsync` to restore the overlay on the switch directly from the tar file,

```
zsync –t overlay.tar
```

The restored overlay will be loaded upon the next reboot.

FILES

```
/etc/exclude, /.zsync
```

SEE ALSO

`zmnt`

ztmd

NAME

ztmd – traffic management daemon which accepts messages from traffic filtering and quality of service applications and sets up hardware.

SYNOPSIS

```
ztmd [-d <level>] [-p <port>] [-f] [-i <pid>]
[-o <pid>] [-a <addr>] [-l]
```

DESCRIPTION

ztmd listens for messages on a multicast port. These messages describe packet filters and queuing disciplines that are to be installed in the switch hardware. ztmd interprets these messages to set up the switch hardware.

OPTIONS

```
-d <level> Set the level of diagnostic information logged.
<level> may be 0-4; higher levels produce more output.

.p <port>  Use <port> as the multicast listening port for
communication with ztmd.  Default is 2345.

-f   Run ztmd in the foreground.  Without this option, it is
run as a daemon.

-i <pid>   Set the PID for this process (default is 1)

-o <pid>   Set expected client PID.

-a <addr>  Bind multicast socket to <addr>

-l   Log diagnostic output to /var/log/ztmd.log
```

EXAMPLES

Start the traffic management daemon, ztmd, then start zqosd to monitor tc output and zfilterd to monitor iptables(8) output. All daemons are run as background processes and log their messages to files in /var/log.

```
ztmd –l

zqosd –l

zfilterd -l
```

SEE ALSO

zqosd, iptables(8), tc(8), zfilterd

brctl(8)

NAME

brctl - Bridge and Spanning Tree Protocol administration.

SYNOPSIS

```
brctl [options]
```

DESCRIPTION

brctl is used to set up, maintain, and display the bridge configuration in the Linux kernel. brctl is a standard command included with Linux bridge support which includes Rapid Spanning Tree Protocol (RSTP) support.

A bridge is a device commonly used to connect different networks together, so that these networks will appear as one network to the participants.

Each of the networks being connected corresponds to one physical interface, or port in the bridge. These individual networks are bundled into one bigger logical network. This bigger network corresponds to the bridge network interface.

Multiple bridges can work together to create even larger networks using the IEEE 802.1d Spanning Tree Protocol and 802.1w Rapid Spanning Tree Protocol. This protocol is used for finding the shortest path between two networks as well as eliminating loops from the topology. Bridges communicate with each other by sending and receiving Bridge Protocol Data Units (BPDUs).

brctl(8) can be used for configuring certain spanning tree protocol parameters. For an explanation of these parameters, see the IEEE 802.1d specification for detailed information.

OPTIONS

```
show  shows all current bridges.

showbr  <bridge>
shows information for the bridge and its attached ports. Check
the priority using this command.

showmacs  <bridge>
shows a list of learned MAC addresses for the bridge.

setgcint  <bridge>  <time>
sets the garbage collection interval for the bridge to <time>
seconds. This means that the bridge will check the forwarding
database for timed out entries every <time> seconds.

stp  <bridge>  <state>
controls this bridge's participation in the Spanning Tree
Protocol. <state> can be “off” or “on”. When turned off, the
```

bridge will not send or receive BPDUs, and will thus not participate in the Spanning Tree Protocol. If your bridge isn't the only bridge on the LAN, or if there are loops in the LAN's topology, DO NOT turn this option off. Turning this option off may impair network traffic, so be careful.

setbridgeprio <bridge> <priority>
sets the bridge's priority to <priority>. The priority value is an unsigned 16-bit quantity (a number between 0 and 65535), and has no dimension. Lower priority values are better. The bridge with the lowest priority will be elected Root Bridge.

setfd <bridge> <time>
sets the bridge's *bridge forward delay* to <time> seconds.

sethello <bridge> <time>
sets the bridge's *bridge hello time* to <time> seconds.

setmaxage <bridge> <time>
sets the bridge's *maximum message age* to <time> seconds.

setpathcost <bridge> <zre#> <cost>
sets the port cost of the port (zre#) to <cost>. This is a dimensionless metric. The path cost is set to 100 for all OpenArchitect switch ports by default. For the OpenArchitect switch a port is zre1, zre2, … IEEE 802.d recommends the following:

Link Speed	Recommended Value	Recommended Range
10 Mb/s	100	50-600
100 Mb/s	19	10-60
1 Gb/s	4	3-10

setportprio <bridge> <zre#> <priority>
sets the port's priority to <priority>. The priority value (a number between 0 and 255), and has no dimension. This metric is used in the designated port and root port selection algorithms. For the OpenArchitect switch a port is zre1, zre2, …

NOTES

`brctl(8)` replaces the older `brcfg` tool.

SEE ALSO

zconfig, zl2d

Appendix B Base Switch Command Man Pages

OpenArchitect applications are implemented above the OpenArchitect libraries and the RMAPI interface. OpenArchitect applications are used for normal operation of the switch, for runtime status and diagnostics, and for prototyping new applications development.

For runtime operation, the OpenArchitect applications perform initialization and configuration, and real-time control and maintenance of the switching tables in the switch silicon. Protocol support is performed by the Linux operating system. In turn the OpenArchitect applications communicate with Linux to determine the appropriate switch table setup.

The initialization of the switch is completed by the `zconfig` application. Through configuration scripts, the user can setup any combination of Layer 2 and Layer 3 switching configurations with VLAN support. Running the `zconfig` command causes network interfaces to be presented to the Linux operating system. These interfaces can be setup for Layer 2 bridging functions such as Spanning Tree Protocol, or Layer 3 routing through the Linux operating system.

`zl2d` is run as a daemon to monitor the Linux operating system bridging function and update the switch silicon accordingly.

`zl3d` is run as a daemon to monitor the Linux operating system routing table information and update the switch silicon switching tables accordingly.

For gathering statistics or prototyping applications, there are OpenArchitect applications that allow any register or table in the switch to be read or written. These applications include `zreg`, `ztats`, and `zarl` and all of the different table equivalents.

vrrpconfig

NAME

vrrpconfig – Configure and control the running vrrpd

SYNOPSIS

```
vrrpconfig [-d <level>] -- <vrrpd parameters>


vrrpconfig [-d <level>] [-k] [-a] [-p] [-s <vid>]
```

DESCRIPTION

vrrpconfig provides communication with a running vrrpd daemon. The -- option for vrrpconfig will pass all parameters to vrrpd as would be done when starting the vrrpd. Any output generated by vrrpd is displayed on the vrrpconfig controlling tty. Any action normally taken by vrrpd for the given parameter is done so by vrrpd. Reference vrrpd for vrrpd parameters and their usage.

OPTIONS

vrrpconfig also has a set of local options that are not passed to vrrpd directly. Many do, however, retrieve information from the running vrrpd. The local options are as follows:

-d <level> Set the debug level. The default debug level is 1. The higher the level, the more debugging output is produced. Debugging output is sent to the controlling tty. This debugging output is from vrrpconfig. To set the debug level of vrrpd, one would use the vrrpd debug level setting option placed after the -- in the vrrpconfig command line.

-a Display in a user readable format, information about the current state of all the Virtual Routers controlled by vrrpd.

-k Kill vrrpd. The entire daemon is killed. Running this command will require that vrrpd be restarted.

-p Display relevant SNMP table values.

-s <vid> Print a numeric representation of the state of the Virtual Router associated with the Virtual Router Identifier <vid>. The numeric representations are 1 = INIT, 2 = BACKUP, and 3 = MASTER

EXAMPLES

Here is an example of using the -- invocation method that changes the priority to 99 for the Virtual Router associated with the Virtual Router Identifier 1:

```
vrrpconfig -- -v 1 –p 99
```

SEE ALSO

`vrrpd`

vrrpd

NAME

vrrpd – Virtual Router Redundancy Protocol Daemon

SYNOPSIS

```
vrrpd -i ifname -v vrid [-f piddir] [-s] [-a auth] [-p prio]
[-nhb] [-I ifname] [-d delay] [-m address] [-M ] [-B]
[-S script] [-c conf_file] [-D level] ipaddr
```

DESCRIPTION

vrrpd is an implementation of Virtual Redundant Routing Protocol (VRRPv2) as specified in RFC2338. It runs in Linux user space. In short, VRRP is a protocol that elects a Master server on a LAN to which the Master answers to a virtual IP address. If it fails, a Backup server takes over the IP address.

VRRP specifies an election protocol that dynamically assigns responsibility for a virtual router to one of the VRRP routers on a LAN. The VRRP router controlling the IP address(es) associated with a virtual router is called the Master, and forwards packets sent to these IP addresses. The election process provides dynamic failover in the forwarding responsibility should the Master become unavailable. This allows any of the virtual router IP addresses on the LAN to be used as the default first hop router by end-hosts. The advantage gained from using VRRP is a higher availability default path without requiring configuration of dynamic routing or router discovery protocols on every end-host.

OPTIONS

The following options are supported by vrrpd:

```
-h    display the usage line

-n    Don't use the virtual MAC address

-b    Run vrrpd in foreground

-i <ifname>     the interface name on which to run the Virtual
Router.  Machines connected with the named interface will see the
Virtual Router Address move with the Master switch

-I <ifname>     the interface name on which to communicate with
other VRRP routers for management of the Virtual Router (default
is the -i interface)

-v <vrid>  the id of the Virtual Router Identifier [1-255].
This value must be a unique value, one per Virtual Router.  In
```

other words there is a unique vrid to ifname associated with the –i option.

-s Toggle preemption mode (Enabled by default). Preemption means that a Master switch will go to Backup if a current Backup has higher priority.

-M Become MASTER when priority is equal. Be sure it is only set on one host or the switches will oscillate. Must set –B option on other hosts (requires preemption mode ! -s)

-B Become BACKUP when priority is equal. See -M option

-S <script> script to be called when state change occurs.

-a <auth> (not yet implemented) set the authentication type auth=(none|pass/hexkey|ah/hexkey) hexkey=0x[0-9a-fA-F]+

-p <prio> Set the priority of this host in the virtual server (default is 100)

-f <piddir> specify the directory where the pid file is stored (default is /var/run)

-c <conf> Configuration read from conf file (required when managing multiple Virtual Routers). The contents of the conf file are lines of command line options. Each line represents a Virtual Router. Parameters given on the command line apply to all Virtual Routers defined by the conf file. So for example, if the command line reads:

vrrpd –d 50 –c vrrpd.conf

And the vrrpd.*conf* file contains:

-v 1 –i zhp0 –I zhp3 10.0.0.42

-v 2 –i zhp1 –I zhp3 11.0.0.42

vrrpd would be started controlling two Virtual Routers; one for 10.0.0.42 and the other for 11.0.0.42. They would both get a –d 50 option.

-d <delay> Set the advertisement interval. Default is 1 second. By default time is specified in seconds. If the delay value ends in a lower case ‘m’ the time is specified in milliseconds. The millisecond specification results in a proprietary use of the VRRP Adver Int field.

-m <address> Change the virtual MAC address from 00:00:5E:00:01:<vid> to the provided addr. The addr should be input as 6 two digit hex numbers that are colon delimited with no

spaces. The –n option overrides the change made with –m. The result of which to use the native MAC address of the interface. Using the –n option is not recommended.

-D <level> Set debugging output to the supplied level

<ipaddr> the ip address(es) of the virtual server

SEE ALSO

vrrpconfig

zbootcfg

NAME

zbootcfg – Modifies the boot parameters of the OpenArchitect switch.

SYNOPSIS

```
zbootcfg -a | -d <device number> [<boot_string>]
```

DESCRIPTION

zbootcfg is used to display or modify the boot parameters on the switch. The boot parameters are utilized by the minof boot loader application to indicate on which device to find a boot image. Care should be taken when changing the boot string. Incorrect procedures can result in a switch that cannot boot.

```
-d <device_number>
Three ROM boot devices are available in the switch. The factory-
shipped boot device is 1. The following describes each boot
device:

-d 1  Boot image located at offset 0 in the application flash 1.
This is the factory-shipped location of the primary OpenArchitect
image.

-d 2  Loads an image located at offset 0 in the application flash
2. This is the factory-shipped location for the alternate
OpenArchitect image.
```

Any characters after the -d <dev> parameters are saved in flash memory and passed unchanged to the booting kernel.

OPTIONS

```
-a    Displays the current boot string. The default factory
shipping string is "dev1."

-d <dev>   Specifies the ROM device from which to boot. The <dev>
value must be the number 1 or 2 corresponding to application
flash 1 or application flash 2, respectively.

<boot string>   Optionally, a boot string may be provided that is
passed to the booting kernel. All characters after the -d <dev>
are passed unchanged to the booting kernel.
```

EXAMPLES

The following example illustrates a command for making the image boot from the second

application flash. Typically this is required before updating application flash 1. By booting the alternative image, if a failure occurs during the programming of application flash 1, recovery is easier.

```
zbootcfg -d 2
```

The next example passes the `-i` option to the booting kernel. This is useful when recovering from a mistake saved to the read-write file system or after updating the application flash 1 and doing the first boot. The `-i` option prevents the read-write file system from overwriting the initial RAM disk image.

```
zbootcfg -d 1 –i
```

SEE ALSO

`zflash, reboot(8)`

zconfig

NAME

zconfig - Configures the OpenArchitect switch.

SYNOPSIS

```
zconfig [-h <host_name>] [-d <level>] [-a] [-t] [{-f <file>} |
<configuration>]
```

DESCRIPTION

zconfig creates VLAN groups of switch ports or trunks. Each VLAN group forms a Layer 2 switching domain. Each VLAN group has a VLAN Identification number (VID) that can be carried in a tag field, located in the header of packets traveling on that VLAN. The configuration of a port determines whether a packet transmitted from that port includes the VLAN tag. A set of up to eight ports may be configured as a trunk, with all links from these ports connect to the same link partner. For each VLAN group created by zconfig, a network interface is also created. After the network interface is started by ifconfig(1M), the VLAN group performs Layer 2 switching. The network interface can be used for Layer 3 routing between VLAN groups.

A network interface uses the following format:

zhpN (for example, zhp0)

N–is an integer between 0 and 9999. The value of N is not required to be the same as any of the port(s) that are its members. The range 0-4999 is reserved for network interfaces created by users. The range 5000-9999 is reserved for network interfaces created by switch applications.

A trunk uses the format zrlK, where K is an integer between 0 and 31, though only 24 ports actually may be used on the base board.

OPTIONS

-h <hostname> Specifies the hostname to configure. By default, zconfig configures the local OpenArchitect switch.

-d <level> Sets the level of debugging output produced by zconfig. The default level is 1. Setting the debug level higher produces more output. The maximum output level is currently four (4).

-a Displays the current configuration of the switch.

-t Tears down the entire switch configuration.

{-f <file>} | <configuration>
Gets configuration information from the specified file. A <file> name of '+' reads configuration data from standard input. If the -f flag is not used, a single line of configuration data can be

entered as parameters to zconfig.

CONFIGURATION SYNTAX

zconfig takes configuration data from standard input or from a file with the -f option. In either case, the configuration syntax is the same. The zconfig configuration data consists of a list of semicolon-delimited statements. Each statement specifies an action to take globally or on an interface. An interface is one of three types: a network interface called ZNYX host port (zhp); a switch port interface called ZNYX Raw Ethernet (zre); or a trunk interface called ZNYX RainLink (zrl).

Comments, spaces and new lines are ignored. Comments begin with the # character and include characters through the next new line.

Global Statements

Global statements can be used to set modes of operation on a switch-wide basis. The only supported global statement is to set and teardown Double VLAN tag mode.

Global Statement Syntax:

Double VLAN tag mode is set and removed on a global basis with the following syntax.

```
dvlan 0x8100 | 0x9100;    (or other unused ethertype)

dvlan teardown;
```

The first option sets double vlan tag mode on all ports and establishes the outer tag id. The second tears down double vlan tag mode.

Trunk Interface Statements

A trunk interface statement begins with the trunk name followed by an equals sign and an action. Trunk interface statements are used to create or tear down trunks or define the rules to determine which member of the trunk should be used to transmit a packet

Trunk interface syntax:

```
zrl0 = <Trunk Interface Action>;
```

Trunk interface actions:

```
List of ports   Creates a trunk interface with the specified port
members.  All of the ports specified must not be a part of any
other trunk, or be individually included in any network
interface.  Up to eight ports can be included in a trunk.
```

A port member is identified with the zre<X> format, where x represents a port number between 0 and 23 for the in-band ports. The Out-of-Band ports cannot be included in the List of ports.

teardown Removes the trunk interface, making the ports which were part of the trunk available for configuration in other trunks or VLANs.

all

mac [source_address | destination_address]

ip [source_address | destination_address]

port [source_port | destination_port]

Further specifies the rules for selecting which port in the trunk a packet should be transmitted out of. A comma delimited list is valid to specify more than one criterion. Specifying a particular option only uses that layer's source and destination information. The default is all, which combines all criteria for determining the transmit port of the trunk. Specifying both source and destination for a given layer is the same as specifying that layer itself, that is,

zrl0=ip source_address, ip destination_address

is the same as,

zrl0=ip

NOTE: The base switch supports `destination_address` and/or `source_address` for `MAC` and `IP`. It cannot combine `MAC` and `IP` settings, nor does it support port settings.

Examples of trunk interface statements:

This statement creates a trunk containing three ports:

```
zrl5 = zre11,zre15,zre17;
```

The following statement specifies that packets will be sent out over this trunk using the exclusive OR of the last three bits of their MAC source and destination addresses to select the port:

```
zrl5 = mac source_address, mac destination_address;
```

The teardown statement uses a colon instead of an equals sign:

```
zrl5: teardown
```

Network Interface Statements

The syntax for a network interface statement is the interface name followed by a colon and an action. Network interface statements are used to create or tear down a VLAN group and can consist of one or a list of network interface names; followed by a colon and then an action. For example:

```
zhp0: <Network Interface Action>;
```

Network interface actions may include:

```
vlan<N> = list of ports or trunks
Creates a network interface and a VLAN group with a VLAN
identification number (VID) consisting of specified port members.

<N>   is an integer between 1-4095.

list of ports or trunks
A port member is identified with the zre<X> format, where x
represents a port number between 0-23 for the in-band ports. A
trunk is identified with the zrl<Y> format, where Y is a number
between 0-31.

If the network interface and VLAN group already exist, the
specified ports or trunks are added to the network interface and
VLAN group.

teardown   Deletes the network interface and the associated VLAN
group.

zre_list = multicast <mac_address>
Register the multicast <mac_address> on the zre_list ports
associated with the given VLAN

multicast_clear Clear all registered multicast address on all the
ports in the VLAN

<list of ports or trunks>  teardown
Deletes the specified ports or trunks from the network interface
and the VLAN group associated with it. If there are no remaining
port or trunk members, then also deletes the network interface
and VLAN group.
```

Examples of Network Interface Statements:

The statement below creates a VLAN group with the VID number 1 and the network interface named zhp5. This VLAN includes a single switch port, zre1.

```
zhp5: vlan1=zre1;
```

The next statement creates a VLAN group with the VID number 100 and the network interface named `zhp1`. This VLAN includes four switch ports, zre1, zre10, zre11, zre13.

```
zhp0: vlan100 = zre1,zre10,zre11,zre13;
```

The next statement adds two switch ports, zre1, zre2 and zre3, to an existing network interface and VLAN.

```
zhp0: vlan100 = zre1..3;
```

The next statement deletes two switch ports, zre1 and zre2, to an existing network interface and VLAN.

```
zhp0: zre1..2 teardown;
```

The final example is a teardown action that deletes the VLAN group defined in the previous example, including the network interface.

```
zhp1: teardown;
```

Port Interface Statements

Port interface statements specify a port or trunk name or a list of such names; followed by an equal sign (=) and then the action. Port interface actions may include:

SYNTAX

```
zconfig <zre_list>=untag<n>

untag<N>   Packets sent from this port or trunk for VLAN <N> are
transmitted without a VLAN tag. The port or trunk specified must
have previously been included in the VLAN group with VID<N>.

zconfig <zre_list> multicast=<forward_type>

<forward_type>  Set the ports specified to act as defined by the
forward_type for multicast traffic.  Possible <forward_types>
are:

forward_unregistered  (default)
forward_all
filter_unregistered
```

Examples of Port Interface Statements:

Assuming that zre1 has been assigned to VLAN 1, to specify that packets sent from port 1 for VLAN 1 are transmitted without a VLAN tag, and packets arriving on this port without a VLAN

tag are given the VLAN tag with the VID number 1, enter:

```
zre1=untag1;
```

If port 0 is also a member of VLAN 100, packets for VLAN 100 are sent from this port with a VLAN tag as part of their header.

In the next example, the switch ports 10, 11, and trunk 2 are configured as untagged members of VLAN 100.

```
zre10,zre11,zrl2=untag100;
```

This statement is equivalent to the following three lines:

```
zre10=untag100;

zre11=untag100;

zrl2=untag100;
```

In the examples above, since port interfaces can only be untagged for one VLAN group, `zre1` cannot also be untagged for VLAN 100. A port or trunk can be a member of multiple VLANs but can only be designated untagged on one VLAN.

WILDCARDS

Wild card characters can be included to simplify the process of creating larger, more complex configurations. Wild card characters for `zconfig` include:

```
,   (comma)     Use for creating lists

..  (dot-dot)   Specifies an inclusive range

+  (plus)  Specifies auto-incrementing
```

Below are some examples for the correct usage of the comma (,) and dot-dot (..). Each line below produces the same results:

```
zhp0: vlan1 = zre1, zre2, zre3, zre4;

zhp0: vlan1 = zre1..4;

zhp0: vlan1 = zre1, zre2..4;

zhp0: vlan1 = zre1..2, zre3..4;
```

The following examples create multiple VLAN groups using a single statement. A list of network interface names are followed by a colon (:) and a list of VLAN actions which are followed by an equal sign (=) and a port list. Each VLAN group is created in turn, along with the corresponding

network interface, and all ports listed after the equal sign are included in each group.

The following statement creates 14 VLAN groups with VID numbers 1-14. Each VLAN contains the same switch port, port 1, represented as zre1.

```
zhp0..13: vlan1..14 = zre1;
```

The plus (+) wildcard can be used with the last port listed to auto-increment that port number before each VLAN group is created. The following network interface statement creates 14 VLAN groups, with the first group containing port 1, the second group port 2, and so on. The second statement configures all ports as untagged in their respective VLANs.

```
zhp0..13: vlan1..14=zre1+;

zre1..13=untag1+;
```

This is equivalent to:

```
zhp0: vlan1=zre1;

zhp1: vlan2=zre2;

zhp2: vlan3=zre3;

      .

      .

zhp13: vlan14=zre14;


zre1=untag1;

zre2=untag2;

zre3=untag3;

      .

      .

zre14=untag14;
```

The previous configuration can be used for creating a 14 port Layer 3 switch, with each port assigned to its own VLAN.

In the next example, one VLAN group, with VID number 1, is created that contains 14 ports. The second statement designates the 14 ports as untagged for the VLAN 1 group.

```
zhp0: vlan1 = zre1..13;

zre1..13 = untag1;
```

The previous configuration can be used for creating a 14 port Layer 2 switch, all 14 ports assigned to the same VLAN.

SEE ALSO

`zl3d`

zcos

NAME

zcos - class of service queue control

SYNOPSIS

```
zcos    [-h <hostname>] [-d <level>]

[ -u <default priority> ]

[ -m q0,q1,q2,q3,q4,q5,q6,q7 ]

[-n <queue length list in packets for each queue> |

 -b <Reserved space in bytes for each queue> |

 -s <limit on dynamic pool usage, in bytes>, <reset %>]

 [ -k PRI | RR | WRR | DRR]

[ -w <queue weight list> ]

[ -g <max>,<burst> ]

[ -r <guaranteed bandwidth in Kbps for each queue> [ -t <burst
size list in Kbytes> ]

[  -l <maximum bandwidth in Kbps for each queue>  [ -t <burst
size list in Kbytes> ]

[ -q all | qmap | qinfo | scheduler ]

[<port list>]
```

DESCRIPTION

zcos provides a means to set many of the hardware features of the switch related to class of service and differentiated services processing, including scheduling and bandwidth management. The current settings can also be examined.

The OpenArchitect switch supports up to eight class of service queues for packets to be sent out each of the Ethernet ports or forwarded to the CPU. Normally, packets are placed in these queues based on their 802.1p priority for tagged packets or the default priority for the port on which they arrive. The queue destination for each priority is determined by a map. A separate map is used for each ingress port. For additional means of setting the cos queue for a packet, see the sections on filtering and traffic control.

Packets are selected from the cos queues at a port based on a scheduler, which may be configured in a variety of modes. The scheduler can provide minimum bandwidth guarantees and limit the bandwidth used for packets from each cos queue. The total egress bandwidth for a port can also be limited.

Each cos queue is limited in the number of packets it can hold waiting scheduling; the memory used by each queue is managed to provide a guaranteed space with additional space shared among all queues for a port.

OPTIONS

Most options are optionally followed by a <port list>, which may include `zre` port ranges, like `zre0..5`, individual ports, such as `zre51`, or cpu, to indicate the queues and scheduling for packets to be transferred to the CPU. The priority and queue mapping options do not apply to the CPU, these settings are provided by the host.

General Options

`-h <hostname>`

Specifies the hostname of the OpenArchitect switch to be configured. Ignore this option if you are configuring on the OpenArchitect switch on which the `zcos` command is being run.

`-d <level>`

Sets the debug level. The default is 1. The maximum is 4.

Priority and Queue Mapping

`-u <default priority> [<port-list>]`

Packets which arrive without a tag have no 802.1p priority. This option assigns a default priority for untagged packets arriving on each port in the <port-list>. The default priority ranges from 0 (lowest) to 7 (highest).

`-m q0,..,q7 [<port-list>]`

Specifies the priority to COS queue map. The first parameter maps priority 0 to queue q0, second maps priority 1 to queue q1, etc. (the queues are numbered 0 to 7). The <port-list> identifies which ingress ports will use this map. If no <port-list> is given, the same map will be used for packets arriving on any of the input ports.

Queue Limits

(These limits should only be changed when the ports are idle)

`-b <Reserved space in bytes for each queue> [<port-list>]`

Specifies the dedicated memory for each cos queue of the ports listed.

`-n <queue length list in packets> [<port list>]`

Sets the number of packets allowed on each cos queue of the ports listed. The total number of packets for all 8 cos queues is limited to 2048.

`-s <limit on dynamic pool usage, in bytes>, <reset %> [<port list>]`

Sets the limit on dynamic memory pool usage by all cos queues for each port listed.

Packets are first counted against the reserved space for a queue. When that space is occupied, additional memory is used from the dynamic memory pool until the dynamic pool usage limit for the port is reached. Any additional packets received for the queue on this port are dropped.

Metering and Scheduling

```
-r <list of bandwidth guarantees in Kbps for each cos queue> [
-t <list of burst sizes in Kbytes>]

[<port-list>]
```

Sets up minimum rate meters for each cos queue. All queues which have not exceeded their minimum transmission rate are scheduled before the other queues.

```
-l <list of bandwidth limits in Kbps for each queue> [ -t
<list of burst sizes in Kbytes>] [<port-list>]
```

Sets up maximum rate meters for each cos queue. Queues which have exceeded their maximum transmission rate will not be scheduled.

```
-k PRIO | RR | WRR | DRR [<port list>]
```

Selects the scheduler mode for the ports listed:

PRIO – strict priority, cos queue 7 is highest priority, queue 0 is lowest

RR – Round robin, a single packet is scheduled from each backlogged COS queue.

WRR – Weighted round robin, a configurable number of packets are scheduled from each queue before moving on to the next.

DRR – Deficit Round Robin, packets are scheduled from a backlogged queue until the configured number of bytes for that queue have been sent.

```
-w <queue weight list> [<port list>]
```

Provides the weights for WRR and DRR scheduling. For WRR, the weights are the number of packets, scaled such that all weights are between 1 and 15. For DRR, the weights are the number of bytes, with a range of 10KB to 160 MB of data.

```
-g <max Kbps>,<burst size in KBytes> [<port list>]
```

Sets a maximum bandwidth meter for all packets transmitted from a port.

The guaranteed and maximum rate meters influence the four scheduling modes. First, those queues which have not met their guaranteed rate and have packets to send are serviced according to the scheduling mode. Then those queues which have not met their maximum rate and have packets to send are serviced. If all queues have met their maximum rate, or the maximum bandwidth for the port has been reached, no packets are sent. Each of the meters is implemented as a separate leaky bucket.

Queries of the Current Settings

```
-q all | qmap | qinfo | scheduler [<port list>]
```

Queries the current COS/QOS Settings.

`all` - Displays all of the queue mappings, queue limits, metering and scheduling settings

`qmap` - Displays the priority to COS queue mappings.

`qinfo` - Displays queue limits for the COS queues.

`scheduler` - Displays the traffic metering and shaping settings and the scheduler mode.

EXAMPLES

1. To set Ethernet ports `zre0` to `zre19` to allow up to 50 packets in priority queues 0-3 and up to 75 packets in queues 4-7:

```
zcos –n 50,50,50,50,75,75,75,75 zre0..19
```

2. To map packet priorities 1-1 to COS queues for packets received on all ports:

```
zcos –m 0,1,2,3,4,5,6,7
```

3. To set up weighted round robin scheduling on ports zre10 to `zre14` and the CPU with a weight of 2 for queue 0, 3 for queue 1, and 1 for all other queues:

```
zcos –k WRR –w 1,3,1,1,1,1,1,1 zre10..14,cpu
```

4. To limit the rate of packets sent to the CPU to 15 Megabits/sec., with bursts of no more than 20,000 bytes:

```
zcos –g 15000,20 cpu
```

5. To guarantee CPU cos queue 5 500 kbps, queue 6 200 kbps, and queue 7 1 mbps, and all other queues no guarantee:

```
zcos –r 0,0,0,0,0,500,200,1000 cpu
```

6. To limit CPU cos queues 0 – 4 to 1000 kbps, with a burst of 20Kbytes:

```
zcos –l 1000,1000,1000,1000,1000 –t 20,20,20,20,20 cpu
```

SEE ALSO

`zfilterd, zqosd, ztmd`

zdog

NAME

zdog - Configure and send heartbeats to watchdog enabled drivers.

SYNOPSIS

```
zdog [-d <level>] -h | -i <interval> | -n <heartbeats>

zdog [-d <level>] -b

zdog [-d <level>] -a
```

DESCRIPTION

zdog is used to configure the base switch watchdog timer functions and to send heartbeats to the base switch watchdog drivers. There are two components to the base switch watchdog timer: A hardware component and a software component. The two components are independent from each other in implementation, but work together to provide safety against zombie hardware and software. The hardware component requires attention on a predefined 1.5 second interval. The driver acts on this at interrupt level to ensure that spurious reboots do not occur. The software component allows for a user programmable interval on which lack of application to driver communication will cause a reboot. Both components can be turned on with zdog.

The options -i and -n are used to configure the expected interval of heartbeats and the number of missed heartbeats of the software component before the base switch should be rebooted. If either the interval or number of heartbeats is 0, the software component is off. The -h option is used to toggle on and off the hardware component of the watchdog timer. The hardware component is off by default.

Once the software component of the watchdog timer is turned on, a heartbeat must be sent with the -b option within that interval or the system will reboot. For example after issuing the following command:

```
zdog -i 5000 -n 3
```

A heartbeat must be sent at least every 3*5000=15000 milliseconds (every 15 seconds). This can be accomplished with something as simple as a polling script with a sleep, or started with a higher level function like monit. The driver checks for heartbeat timeout approximately 3 times per second. So (<heartbeat intervals>*<number of heartbeats>) faster then 330 milliseconds will have diminishing returns.

Combining monit and zdog allows multiple levels of insuring system integrity. The hardware component of zdog insures that the CPU is functioning well enough to execute something. The

software component of `zdog` when launched from `monit` insures that `monit` is running to perform higher level tasks. And finally `monit` can be used to monitor any or all critical system resources and processes in the system.

OPTIONS

```
-d    set debug level to <level>

-h    Toggle use of the hardware watchdog timer.  Off by default.

-i    Time interval in milliseconds between zdog to driver
heartbeats

-n    Number of missed heartbeats before system reboot

-b    Send a single heartbeat to the driver

-a    Display current configuration
```

zffpcounter

NAME

zffpcounter—Query or clear one or more Fast Filter Processor (FFP) counters.

SYNOPSIS

```
zffpcounter -P <zre_port> [-p <ppa>] [-i <index>]   [-h
<hostname>] [-c] [-d <level>]
```

DESCRIPTION

The switch enforces filtering rules through the FFP. Each filtering rule may specify an FFP counter, to be incremented for every packet that matches that rule.

The zffpcounter command is used: (a) for querying the current value(s) of one or more counters; or (b) for resetting one or more counters to zero. If a rule includes metering if the rule is matched,
only packets which are in-profile increment the counter. Out of profile packets are counted in the FFP out of profile counters, which are displayed using zffppacketcounter, which has exactly the same format and syntax as zffpcounter.

The iptables or zirule utilities may be queried to see which rules, if any, are using FFP counters.

OPTIONS

-h <hostname> Specifies the hostname to query/clear. By default, zffpcounter uses the local OpenArchitect switch.

-p <ppa> Specifies the Physical Point of Attachment (PPA) on which to query/clear. By default, zffpcounter uses the value 0.

-c Specifies that zffpcounter should clear the specified counter(s), rather than querying.

-d Sets the level of debugging output for zffpcounter. The default level is one (1), which reports all errors. Setting the debug level higher produces more output. Three (3) is currently the maximum output level.

-i <index> An index whose counters should be queried/cleared. Individual values (such as 5) are acceptable. If no index is given, zffpcounter uses all counters.

-P <zre_port> (required) Print table entry that contains <zre_port> (zre<n>).

EXAMPLES

The first example queries all FFP counter values.

```
zffpcounter
```

The output displays the initial state of the counters. Note that the counters are not initialized on startup,

```
Counter 0: 59602801
Counter 1: 83360091
Counter 2: 83361262
      .
      .
      .
Counter 29: 83074779
Counter 30: 81723249
Counter 31: 71007391
```

The next example clears all FFP counter values.

```
zffpcounter -P –c
```

Now using `zffpcounter` to display,

```
zffpcounter

Counter 0: 0
Counter 1: 0
Counter 2: 0
      .
      .
      .
Counter 29: 0
```

```
Counter 30: 0
Counter 31: 0
```

`iptables(8)` is used to setup a rule, and associate that rule with a counter. For instance, add a rule to accept all packets from 10.0.0.11 and associate that rule with FFP Counter 1.

```
iptables –A FORWARD –s 10.0.0.11 –j ZACTION --accept
--counter 1
```

Start `zfilterd` to move the rule entered with `iptables(8)` down into the switching silicon.

```
zfilterd
```

Counter 1 will now increment as traffic is sent to the switch from host 10.0.0.11.

```
zffpcounter


Counter 0: 0
Counter 1: 98
Counter 2: 0
      .
      .
      .
```

The next example queries ports 2-7, 15, and 19-21.

```
zffpcounter -P 1..4, 15, 19..21


Counter 1: 98
Counter 2:  0
Counter 3:  0
Counter 4:  0
Counter 15: 0
```

```
   Counter 19: 0
   Counter 20: 0
   Counter 21: 0
```

SEE ALSO

zirule, iptables(8)

zfilterd

NAME

zfilterd - A daemon to use the filter hardware of the OpenArchitect switch for filtering based on iptables(8) rules.

SYNOPSIS

```
zfilterd [-d <level>] [-p <port>] [-f] [-l] [-i <pid>] [-o <pid>]
```

DESCRIPTION

zfilterd is a daemon that intercepts filtering rules entered by the user, using iptables(8), checks them for validity and then prepares messages for the traffic management daemon ztmd, which is responsible for setting up the switch hardware for the filtering rules and actions.

OPTIONS

-d <level> Sets the level of debugging output required by zconfig. The default level is one (1). Setting the debug level higher produces more output. Four (4) is currently the maximum output level.

-p <port> Set the multicast port to which messages will be sent.

-f Run zfilterd in the foreground, by default, it runs in the background.

-l Log all diagnostic output to /var/log/zfilterd.log.

-I <pid> Set our pid used in identifying ourselves to ztmd

-o <pid> set the pid of the ztmd process we will communicate with.

SEE ALSO

ztmd, zrule, iptables(8)

zflash

NAME

`zflash` – Loads images into the flash ROMs on the OpenArchitect switch.

SYNOPSIS

```
zflash -d <dev> [-o|-O <offset>] <image_file>

 <upgradeipmi.img>
```

DESCRIPTION

`zflash` enables you to program the flash ROMs on the switch. The switch contains 3 flash ROM devices: the boot ROM flash, application flash 1 and application flash 2. Care should be taken when flashing new images into the switch. Incorrect procedures can result in a switch that cannot boot; especially when flashing the boot ROM referred to as device 0. See *Switch Maintenance* for updating the flash ROM images.

OPTIONS

`-d <dev>  Specifies the ROM device being programmed. Dev must be a number 0, 1, or 2 corresponding to the boot ROM, application flash 1, or application flash 2 respectively.`

`-i <upgradeipmi.img> will load the file <upgradeipmi.img> into the IPMI controller flash memory.  This updates the program version, it does not affect the FRU data.`

> `Progress indicators will be printed during the update. It may take four minutes to flash.`
>
> `Once the update is complete, the IPMI controller is rebooted, which may cause the shelf manager to temporarily disable fabric ports until the reboot is complete.`

EXAMPLES

The following example loads a new initial RAM image into application flash 1 at the default offset of 0:

```
zflash -d 1 rdr6000.zImage.initrd
```

The following example loads a new boot image into the boot ROM at the default offset of 0:

```
zflash -d 0 zx6000.img
```

Exercise caution when using this command, as an error can render your switch inoperable. Do not interrupt this process until complete.

SEE ALSO

`zbootcfg`

zgmrpd

NAME

zgmrpd - GARP Multicast Registration Protocol (GMRP) daemon for the OpenArchitect switch. (Partially supported in this release.)

SYNOPSIS

```
zgmrpd [-d <level>] [-f] [-h <hostname>] [-p <ppa>] [-t <target>]
```

DESCRIPTION

zgmrpd is run after the network interfaces are created and initialized with zconfig, and started with ifconfig(1M).zgmrpd starts a background task that implements the GARP Multicast Registration Protocol (GMRP) protocol for a specified interface, either a zhp or bzhp. GMRP provides a Layer-2 mechanism for determining which ports in a VLAN are listening to which multicast addresses. zgmrpd updates the multicast table in silicon with this information, so that the multicast traffic is forwarded only to the ports in a VLAN to which listening hosts are attached. This optimizes packet flow through the switch. The background task started by zgmrpd continues throughout the life of the Layer 2 network. GMRP is specified in *ANSI/IEEE Std 802.1D, 1998 Edition*.

zgmrpd manages the switch multicast table (MARL). Based on GMRP packets received on the target interface, zgmrpd creates, updates, or deletes an entry in the MARL. The key to each MARL entry is a source Ethernet multicast address combined with a VLAN ID. Two port bitmaps are maintained: one that identifies the untagged members of the VLAN, and one which identifies which ports of the VLAN have listening hosts attached.

NOTE: OpenArchitect does not tag BPDU packets. This means that if a port belongs to multiple VLANs, exactly which Multicast MAC/VLAN entry to create, modify, or delete cannot be determined. GMRP should not be used when ports belong to multiple VLANs. If the target is a zhp, it's recommended that the zhp contain all the ports on the switch.

When the maximum number of entries in the MARL is reached, zgmrpd deletes a random entry prior to adding the next entry.

By default, while GMRP is running, unregistered multicast traffic is filtered on the target interface. The GMRP protocol provides a mechanism for changing the filtering behavior on a per-port basis. Filtering behavior can be set to filter unregistered multicast traffic, forward unregistered multicast traffic, or forward all traffic. zconfig can be used to set the filtering mode of each port. See zconfig . Ports connected to routers should be set to "Forward All" filtering mode manually with zconfig after zgmrpd is up and running. When zgmrpd is terminated, filtering behavior is set to forward unregistered multicast traffic on each port in the target interface.

Only the GARP normal registration mode is currently supported.

Multiple instances of `zgmrpd` may run concurrently provided the targets are unique. However, `zgmrpd` cannot run concurrently with `zsnoopd`. See `zsnoopd`.

OPTIONS

```
-d <level>
Sets the level of debugging output required by zgmrpd. The
default level is zero (0). Setting the debug level higher
produces more output. Five (5) is currently the maximum output
level.

-f   Run zgmrpd in foreground. Default is to run it in
background.

-h <hostname>
Connect to remote host <hostname>.

-p <ppa>
Start zgmrpd on switch <ppa>. Default is 0.

-t <target>
Enable GMRP on the set of ports specified by the target, either a
zhp or bzhp interface. There is no default. A target must be
specified.
```

EXAMPLES

In the following example, `zgmrpd` starts a background task that enables the GMRP protocol for the ports in the `zhp0` interface. `zgmrpd` receives and sends GMRP packets, and updates the Multicast Table (MARL) accordingly. This background task continues throughout the life of the Layer 2 network, or until manually terminated.

```
zgmrpd –t zhp0
```

Once you run `zgmrpd`, use `zmarl` to display the contents of the MARL. `zgmrpd` deletes all entries in the MARL when starting up, and when shutting down. Manual changes to the MARL can be made while `zgmrpd` is running. However, all such changes will be deleted when `zgmrpd` is terminated.

SEE ALSO

```
zconfig, zsnoopd
```

zgr

NAME

`zl2, zl2mc, zl3host, zl3net, zvlan` – Formatted display of OpenArchitect generic tables.

`zl2` displays the abstraction API's layer 2 table.

`zl2mc` displays the abstraction API's layer 2 multicast table.

`zl3host` displays the abstraction API's layer 3 host route table.

`zl3net` displays the abstraction API's layer 3 network route table.

`zvlan` displays the abstraction API's VLAN table.

SYNOPSIS

```
zl2 [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-P port] [-h <host_name>] [-d <level>]


zl2mc [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-P port] [-h <host_name>] [-d <level>]


zl3host [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-P port] [-h <host_name>] [-d <level>]


zl3net [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-P port] [-h <host_name>] [-d <level>]


zvlan [-i <index>] [-m <mac_address>] [-a]
[-v <vlan_id>] [-h <host_name>] [-d <level>]
```

DESCRIPTION

The generic table display functions produce formatted output of the abstraction API's tables for display on the user console. The format of the output is table-dependent. Port mapping affects the ports referenced in the generic tables. (Ports listed in order from 1 to 15)

Headers describing the column being displayed are printed after every 22 lines of output, which makes it easy to pipe through *more(1)*. The abstraction layer tables grow and shrink as entries are added and deleted.

Several options are available which enable the user to display only selected entries. Additionally, there is an option that clears user-specified entries in the table.

OPTIONS

```
-i <index> Displays the entry at the <index> position in the
table. Valid for all tables. Cannot be combined with -m, -P or -v
.

-m <mac_address>
Displays entries whose MAC address field matches <mac_address>.
Only valid for tables that have a MAC address field. Cannot be
combined with -i, -P, or -v.

-a   Displays the entire table.

-v <vlan_id>    Displays entries whose VLAN ID field matches
<vlan_id>. Only valid for tables that have a VLAN ID field.
Cannot be combined with -i, -m, or -P.

-P <port>  Displays the entries whose port field matches <port>.
Only valid for tables that have a PORT ID field. Cannot be
combined with -i, -m, or -v.

-h <host_name>  Specifies which hostname to connect. By default,
zgr connects to the locally connected OpenArchitect switch (that
is, the one that is on the local PCI bus).

-d <level>      Sets the level of debugging output required by
zgr. The default level is one (1). Setting the debug level higher
produces more output. Four (4) is currently the maximum output
level.
```

EXAMPLES

The following example searches for and displays an entry in the *zl2* table with the specified MAC address:

```
zl2 -m 00:c0:95:45:00:00
```

If there is an entry in the ZL2 table with the MAC address, 00:c0:95:45:00:00, all the fields of that entry will be displayed.

The following command deletes the above entry:

```
zl2 -c -m 00:c0:95:45:00:00
```

The following command displays all entries of the *zl2* table:

```
zl2
```

Be careful, the `-c` option does not ask. The following command deletes all entries in the `zl2` table:

```
zl2 -c
```

SEE ALSO

```
zal
```

zgvrpd

NAME

zgvrpd - GARP VLAN Registration Protocol (GVRP) daemon for the OpenArchitect switch.

SYNOPSIS

```
zgvrpd [-d <level>] [-f] [-h <hostname>] [-p <ppa>] [-t <target>]
```

DESCRIPTION

zgvrpd is run after the network interfaces are created and initialized with zconfig, and started with ifconfig(1M).zgvrpd starts a background task that implements the GARP VLAN Registration Protocol (GVRP) protocol for a specified zhp interface. GVRP provides a Layer-2 mechanism for dynamically managing port membership in VLANs, including adding and deleting ports, and creating and deleting VLANs. The background task started by zgvrpd continues throughout the life of the Layer 2 network. GVRP is specified in *ANSI/IEEE Std 802.1Q, 1998 Edition*. The GARP protocol on which GVRP is based is specified in *ANSI/IEEE Std 802.1D, 1998 Edition.*

zgvrpd updates the switch's VLAN configuration, based on GVRP packets received on the target interface. Specifically, it adds a port to or deletes a port from the VLAN specified in the GVRP packet. If the VLAN does not exist, zgvrpd creates it. If zgvrpd deletes the last port from a dynamically-created VLAN, it also deletes the VLAN.

When a VLAN is dynamically created, a corresponding zhpN interface is also created, where N is an integer between 5000 and 9999. The value of N is equal to 5000 plus the VLAN identification number (VID). For example, if zgvrpd creates VLAN 5, it also creates a zhp5005.

zgvrpd learns the existing (static) VLAN configuration of its target when starting up. When shutting down, zgvrpd deletes only the dynamic changes to the VLAN configuration that it has made. Manual changes to the VLAN configuration can be made while zgvrpd is running. However, all such changes will be deleted when zgvrpd is terminated.

Only the GARP normal registration mode is currently supported. Multiple instances of zgvrpd may run concurrently provided the targets are unique. If zgvprd's target is a zhp, it's recommended that the zhp contain all the ports on the switch.

zgvrpd cannot be run concurrently with zsnoopd, because zsnoopd assumes static VLAN membership.

OPTIONS

```
-d <level>
Sets the level of debugging output required by zgvrpd. The
```

```
default level is zero (0). Setting the debug level higher
produces more output. Five (5) is currently the maximum output
level.

-f    Run zgvrpd in foreground. Default is to run it in
background.

-h <hostname>
Connect to remote host <hostname>.

-p <ppa>
Start zgvrpd on switch <ppa>. Default is 0.

-t <target>
Enable GVRP on the set of ports specified by the target zhp
interface. There is no default. A target must be specified.
```

EXAMPLES

In the following example, `zgvrpd` starts a background task that enables the GVRP protocol for the ports in the `zhp0` interface. `zgvrpd` receives and sends GVRP packets, and updates the VLAN configuration accordingly. This background task continues throughout the life of the Layer 2 network, or until manually terminated.

```
zgvrpd –t zhp0
```

Once you run `zgvrpd`, use `zconfig –a` to display the current VLAN configuration.

SEE ALSO

`zconfig, zsnoopd`

zl2d

NAME

zl2d - Layer 2 daemon for the OpenArchitect switch.

SYNOPSIS

```
zl2d [start | stop] [-t <msecs>] [-d <level>] [-f]
     [-p <priority>] <iface..>
```

DESCRIPTION

zl2d is run after the network interfaces are created and initialized with zconfig. zl2d creates a Linux bridge for each interface using brctl(8). The bridge name is the interface name with a 'b' pre-pended to it. This command is primarily used for Spanning Tree Protocol (STP). Each port associated with the interface is included within the bridge. zl2d starts a background task that continues throughout the life of the Layer 2 network. zl2d is a script that can be modified to include brctl commands when started and stopped. Examine /usr/sbin/zl2d for examples of how to change common options.

OPTIONS

start | stop Starts or stops the zl2d daemon.

-t <msec> Cause zl2d to monitor the Spanning Tree state of each port on each bridge every <msec> milliseconds. If unspecified, the default is 500 milliseconds.

-f Enables Fast Forward on bridge(s) using 0x4000 (16384) as the dynamic root priority.

-d <level> Sets the level of debugging output required by zl2d. The default level is one (1). Setting the debug level higher produces more output. Four (4) is currently the maximum output level.

-p <priority> Sets the dynamic root priority. <priority> should be specified as a decimal number. A priority of 0 disables root priority change.

<iface…> The network interfaces on which zl2d should operate. These network interfaces must first be created by zconfig. zl2d does not operate with standard network interface cards. It only works on switch network interfaces created by zconfig.

OPERATIONS

`zl2d` manages the Spanning Tree state fields in the switch of each port within the bridge(s). Based on a timer, `zl2d` reads the port information for each Linux bridge and updates the switch when necessary.

EXAMPLES

In the following example, `zl2d` creates a Linux bridge named `bzhp0` which includes all of the `zre<n>` devices previously associated with the `zhp0` device. `zl2d` then starts a background task that monitors the port information of the Linux bridge every 500 ms. and updates the Spanning Tree state fields in the hardware when necessary.

```
zl2d -t 500  zhp0
```

Once you run `zl2d`, use `brctl(8)` to display and alter your Spanning Tree settings.

SEE ALSO

`zconfig, brctl(8)`

zl3d

NAME

zl3d - Layer 3 daemon for the OpenArchitect switch.

SYNOPSIS

```
zl3d [-h <host_name>] [-t <msecs>] [-b] [-e] [-l] [-n] [-d
<level>] <iface ..>
```

DESCRIPTION

zl3d is run after the network interfaces are created and initialized with zconfig, and started with ifconfig(1M). zl3d listens for Netlink messages from the kernel and monitors the Linux network routing tables for routing updates. When an update occurs, if appropriate, zl3d updates the corresponding routing tables in the silicon so that Layer 3 forwarding is done in the switch at line speed. zl3d also ages the switch host route entries.

zl3d attempts to keep the Linux route cache and the switch host route table consistent. When a host route table entry is in use, zl3d updates the Linux route cache. Host route table entries are deleted when Linux removes the corresponding entry from the route cache. Similarly, network route entries are removed when the corresponding Linux FIB table entry is deleted.

OPTIONS

-h <hostname> Specifies which host to monitor. By default, zl3d monitors the OpenArchitect switch that is locally connected (i.e., the one that is on the local PCI bus).

-t <msec> Sets the timeout value. By default, zl3d wakes up every 15 seconds (15000 ms) to look for updates to the Linux routing tables and to do aging processing of route table entries on the switch.

-b Do not background the zl3d process.

-e Enables additions of a default route to the L3 network route table.

-l Leave hardware tables intact on exit.

-n Writes the proc table entry. zl3d writes 3/2 of it's timeout value to /proc/net/sys/ipv4/route/route_expires. The Linux kernel uses this value as an expiration time for cache routes updated by zl3d.

-d <level> Sets the level of debugging output required by zl3d. The default level is one (1). Setting the debug level higher

produces more output. Four (4) is currently the maximum output level.

<iface…> The network interfaces on which zl3d should operate. These network interfaces must first be created by zconfig. zl3d does not operate with standard network interface cards. It only works on switch network interfaces created by zconfig. It uses the same syntax as zconfig.

OPERATIONS

zl3d manages the host route and network route tables located in the switch. Based on a trigger condition, zl3d reads the Linux FIB table and the Linux route cache. Each table entry is filtered by zl3d according to the following:

- If an entry from the route cache is not a broadcast address or a local address, and zl3d is able to resolve the MAC address of the destination, then zl3d inserts the entry into the switch host route table.
- If an entry in the Linux FIB table is a host entry and zl3d is able to resolve the MAC address of the destination host, then the entry is inserted into the switch host route table. If an entry from the FIB table is a gateway entry, is not local, and zl3d is able to resolve the MAC address of the gateway, then the entry is inserted into the switch network route table.

EXAMPLES

Normally, zl3d is run as a background task that continues throughout the life of the Layer 3 network.

In the following example, for the three interfaces specified, zl3d continuously monitors the Linux FIB and route cache tables looking for updates every three seconds. Entries in the switch host route table are checked for activity every 15 seconds and aged accordingly.

```
zl3d zhp1 zhp2 zhp3
```

SEE ALSO

zconfig

zlc

NAME

zlc – link and LED control

SYNOPSIS

```
zlc [-h <hostname>][-d <level>][-x] <port_list> <action> [on |
off ]

zlc [-h <hostname>][-d <level>][-x] <action> [on | off |clear]

zlc [-h <hostname>][-d <level>][-x] [state|query]
```

DESCRIPTION

The zlc application sets the link speed and state of individual ports of the switch, or displays the current state. It can also turn on or off the extract LED or the internal fault LED.

OPTIONS

-h <hostname> Connect to remote host <hostname>.

-d <level> Set debug level to <level>

-x Expected query value. Creates no output, exit code only. If the port_list contains more than one port, returns the number of ports that match the option.

<port_list> Port or list of ports on which to take action. Port lists are supplied in zconfig syntax (e.g. zre1, zre2..4, etc.)

<action> Set link speed or state to up, down, auto, 1000fd, 1000hd, 100fd, 100hd, 10fd or 10hd. The interface must be down to change the port speed. Set intfault or extfault. Must supply <option>.
Use query to return present settings.

on | off Turn on or off the specified LED. Only valid for actions intfault, extfault or extract.

clear No longer globally control the specified LED

state Return the list of LEDs currently illuminated.

query Return the list of LEDs currently controlled globally.

EXAMPLES

In the following example, zlc forces the line speed of port 1 to 100 Full duplex. The interface

must be down to change the speed. Assuming zre1 is part of interface `zhp0`,

```
ifconfig zhp0 down
zlc zre1 100fd
```

The external fault, internal fault, and ok LEDs can be set on a per port basis or *globally*. To set the external fault LED for a particular port,

```
zlc zre1 extfault on
```

To query the settings of a particular port,

```
zlc zre1 query
```

Global Settings

The external fault, internal fault, and extract LEDs are set as a logical OR of all the ports. The LEDs can also be set globally to on, off, or other. If globally set to on or off, the LED will not change when links go up or down ,or interfaces are configured. If set to other, the LED resumes its normal operation.

The next example globally turns on the Pull (extract) LED.

```
zlc extract on
```

Additional capabilities are also available by supplying an additional led action:

```
zlc <led_name> on
```

The `<led_name>` LED is turned on. The LED will not change when links go up or down or interfaces are configured. If other is used, the LED resumes its normal operation. `<led_name>` can be `intfault, extfault, extract`, or `ok`.

```
zlc query
zlc state
```

query lists the LEDs which have been set globally on or off. state shows which LEDs are on at the moment. All LEDs are shown, including the `clk` LED.

SEE ALSO

`ifconfig(8)`

zlmd

NAME

zlmd – monitor link changes or hot swap events.

SYNOPSIS

```
zlmd [-h <hostname>] [-b] [-d <level>] {-f <file>} |
<configuration>
```

DESCRIPTION

The `zlmd` application is intended to run as a daemon, waiting for a configured event to occur and then running the program configured for that event. The events monitored are changes in the link status of any of the 24 inband ports of the switch, the start of removal of the switch from the back plane, or the cancellation of the removal before it actually takes place. The program can be a shell script that initiates appropriate actions to respond to the event.

OPTIONS

`-h <host_name>  Connect to remote host <host_name>`

`-b Do not background the zlmd process.`

`-d <level> Set debug level to <level>.`

`{-f <configuration_file>} | <configuration>`

```
     Read configuration from <file>.  If file is a '+',
configuration is read from stdin.  Without the -f option, a
single line of input can precede the last flag.  (i.e.
<Configuration>)
```

CONFIGURATION SYNTAX

`zlmd` takes configuration data from standard input or from a file with the `-f` option. In either case, the configuration syntax is the same. The `zlmd` configuration data consists of a list of semicolon-delimited statements. Each statement specifies an event to monitor followed by a response action.

Configuration commands:

```
<port-list> = <program>
Run <program> when a fault occurs or clears on a port.

hotswap = <program>
Run <program> when a hot-swap extraction or insertion event
occurs.
```

<port-list> A list of ports in the same forms supported by zconfig, e.g. zre1,zre2 or zre10..14

<program> Path to an executable program or script to be run when the event occurs. Note: An absolute path to <program> is required. The program will be called with the following parameters:

For Link Changes:

 <program> <ppa> <port> {external(0)|internal(1)} {off(0)|on(1)}

For Hot-swap Events:

 <program> <ppa> {extraction(1)|insertion(2)}

NOTE: The <ppa> parameter is undefined and should be ignored.

EXAMPLES

In the following example, `zlmd` monitors ports 1 through 4 and runs a script called `prt_change` upon a link change event.

```
zlmd zre1..4=/usr/sbin/prt_change
```

Suppose port 2 were UP and you disconnected the cable, `zlmd` would call `prt_change` with the following parameters:

```
/usr/sbin/prt_change 0 2 0 1
```

where 0 is the ppa, 2 is the port, 0 is an external fault, 1 is ON.

SEE ALSO

`zconfig`

zlogrotate

NAME

`zlogrotate` – Rotates log files.

SYNOPSIS

```
zlogrotate [-b] [-t time] [-s segment size] [-n # of files] [-f
file to rotate]
```

DESCRIPTION

`zlogrotate` rotates the selected file every [time] seconds if the file is larger than [segment size]. It will keep only the number of files selected. `zlogrotate` is called from /etc/init.d/rcS by default with no parameters.

OPTIONS

```
-b    Do not background the process - i.e. run in foreground.

-t <time>  the time between logfile checks in seconds (default
60)

-s <size>  the targeted file segment size, in kilobytes (default
256)

-n <# of files> The number of segments kept on the system
(default 4)

-f  <file> The file to rotate (default /var/log/messages)
```

EXAMPLES

To start `zlogrotate` with the default values,

```
zlogrotate
```

zmirror

NAME

zmirror - Set packet mirroring on an ingress or egress port

SYNOPSIS

```
zmirror  -a | -t

zmirror  [-e] <from_list> <to_port>
```

DESCRIPTION

zmirror sets packet mirroring from a given set of ports to one given port. Turning on packet mirroring causes a copy of the packet to be sent to the *to* port. Any number of *from* ports can be mirrored to one *to* ports.

NOTE: There are performance issues when trying to mirror more bandwidth than is available on the *to* port.

After executing the following command, packets received on ports 1, 2 and 3 would be mirrored (copied and transmitted) to port 12. This mirroring would be in addition to any Layer 3 or Layer 2 switching.

```
zmirror zre1, zre2, zre3 zre12
```

To clear the current mirroring, use the -t option.

The -e option can be used to indicate that packets being sent on a given port should be copied to the *to* port. For example if the -e option is used as follows, the packets transmitted, as opposed to received, on ports 1, 2 or 3 would be mirrored to port 12.

```
zmirror -e zre1, zre2, zre3 zre12
```

The *to* port can also be the keyword cpu to indicate that packets should be forwarded to the on-board processor. The following example would mirror the contents of port 1, 2 or 3 to the on-board processor:

```
zmirror zre1, zre2, zre3 cpu
```

The *to* port can be a single port or the keyword cpu. The from port can be a list consisting of one or more ports. The *from* port cannot be the cpu. See the section on wildcards for discussion of from port lists.

zmirror is cumulative:

```
zmirror zre1, zre2, zre3 cpu
```

Is the same as:

```
zmirror zre1 cpu

zmirror zre2 cpu

zmirror zre3 cpu
```

Multiple mirroring setups can be made. The following example will mirror port 1 traffic to port 11 and port 2 traffic to port 12.

```
zmirror zre1 zre10

zmirror zre2 zre11
```

Setting a different *to* port will overwrite the previous setting. Given the last setup the following will change port 1 traffic to be forwarded to port 10.

```
zmirror zre1 zre10
```

The following example results in ingress mirroring from port 0 to port 1and from port 2 and 3 to port 18.

```
zmirror zre0 zre1

zmirror zre2 zre12

zmirror zre3 zre18
```

The *to* port of 12 was over written with the *to* port 18 .

Use `zmirror –a` to query the hardware to display the current configuration.

```
zmirror -a
```

OPTIONS

`-a` Display the current mirroring setup

`-e` Set egress port mirroring for the specified *from* port

`-t` Teardown or disable the mirroring

WILDCARDS

Wildcard characters can be included to simplify the process of creating larger, more complex configurations. Wild card characters for `zconfig` include:

```
,   (comma)     Use for creating lists

..  (dot-dot)   Specifies an inclusive range
```

Below are some examples for the correct usage of the comma (,) and dot-dot (..). Each line below produces the same results:

```
zre1, zre2, zre3, zre4

zre1..4

zre1, zre2..4

zre1..2, zre3..4
```

SEE ALSO

`tcpdump(1M)`

zmnt

NAME

zmnt – Expands the read/write files onto the RAM disk.

SYNOPSIS

```
zmnt [-c] <directory>

zmnt [-c] -t <file>

zmnt [-c] -l
```

DESCRIPTION

zmnt expands files from flash onto the RAM disk that have been previously saved with zsync. The init process runs zmnt to expand the files in flash onto RAM file system. The user may use zmnt to expand the files at anytime and may place them in any directory. For example,

```
zmnt /tmp
```

will expand the files under the directory /tmp.

Booting the kernel with -i instructs the init process to skip the zmnt stage After booting in this way, zmnt can be used for correcting a problem file in the read-write file system.

The -t option can be used to save the configuration of a switch to a tar file. A tar file can be copied to another switch and saved with zsync -t. As a result, the configuration of a switch may be cloned to other switches.

The -c option is used to mount the custom overlay. See zsync for a description of custom verses dynamic overlay.

OPTIONS

```
-c    Read saved files from the custom overlay

-t <file>
Save the overlay into the specified <file> in tar format.

<directory>     The directory under which the overlay files are
expanded, or the file to which the tar image is saved.

-l    List files in selected overlay, do not unpack.
```

EXAMPLES

In the following example, zmnt the current overlay into a tar file called overlay.tar

```
zmnt –t overlay.tar
```

The resulting tar file can now be saved on a different host as a snapshot of the overlay at that point in time. Use `zsync` to restore the overlay on the switch:

```
zsync –t overlay.tar
```

The restored overlay will be used upon the next reboot.

SEE ALSO

`zsync`

zpeer

NAME

zpeer – Application for High Availability communication between the Fabric and Data switches.

SYNOPSIS

```
zpeer [-d <level>] local|peer <command> <value>|query

zpeer [-d <level>][-a][-r]
```

DESCRIPTION

zpeer is used to pass bidirectional High Availability(HA) state and priority information between the base and fabric switches in the Ethernet Switch Blade. zpeer uses the concept of local and peer information. The local information is written, and the peer information is read. As an example:

On the base switch:

```
zpeer local priority 203
```

On the fabric switch the following command would return 203:

```
zpeer peer priority query
```

The communication is bidirectional so the example above can be reversed allowing the fabric switch to pass state and priority information to the base switch.

NOTE: Local information can also be read as confirmation and for debugging purposes.

zpeer is part of the HA software suite. It is called as part of the scripts that are generated by the zspconfig application. With the exception of querying information for debugging and validation, the zpeer application would not need to be executed by the user. Following is a quick overview of the values communicated between switches. See documentation on HA and zspconfig for better understanding of how zpeer fits in with the HA software suite.

Following is an example of setting the state to "backup":

zpeer local state backup

Possible states are:

unhealthy	Set by hardware at power up or at system reboot. Set by software when the HA software suite is stopped. Indicates that the peer is not properly functioning
healthy	Set by software when HA is started. This state is never

	displayed by query, but must be set at initialization. After setting the healthy state, the query will return the backup state.
backup	Used to reflect the backup state of vrrpd
master	Used to reflect the master state of vrrpd

The priority value is a value between 0 and 255. In the HA suite, the value is set to 254 minus the number of ports that are link down.

The state or priority value for the local or peer can be displayed with the query command. The following will query the state of the peer switch:

```
zpeer peer state query
```

The output from the above command during the boot process would be “unhealthy”

The `-a` option can be used to display a complete listing of all state and priority information and internal information that can be used for debugging. Here is example output from the `-a` option.

```
                       Local/Write      Peer/Read
priority                 203        231
state                    master           backup

data                      2|cb             2|e7
position byte|bit         2|8              2|0
status                    50(ACK)     0()
```

The priority and state rows are the same values returned by the query command. The information in the data, position and status rows are internal debugging information that is useful to support engineers when diagnosing problems in the field.

The `-r` option should not be used while HA is running. It can cause loss of coordination between the two switch planes. The `-r` option will reset all internal communication values, and possibly require the peer to be reset also.

OPTIONS

```
   -d    set debug level to <level>

   -a    Display complete status of zpeer

   -r    Reset all values in the zpeer communication.  Can cause
         loss of communication with the peer requiring the peer to
```

```
        be also reset.
```

SEE ALSO

```
zspconfig
```

zqosd

NAME

zqosd – monitors tc(8) commands to implement classification filters and queuing disciplines in hardware.

SYNOPSIS

```
zqosd [-d <level>] [-p <port>] [-f] [-l] [-i <pid>] [-o <pid>]
```

DESCRIPTION

zqosd monitors commands entered by tc which set up queuing disciplines and classification filters for managing traffic in the switch. It supports a variety of queuing disciplines which allow distributing available bandwidth at each output port of the switch among different classes of traffic as well as selecting which packets to drop when bandwidth limits are exceeded.

zqosd does not directly set up the hardware. It prepares messages describing the queuing disciplines and filters and sends them to a hardware specific daemon, ztmd. ztmd should be started before zqosd. Both programs normally run as background processes.

OPTIONS

-d <level> Set the level of diagnostic information logged. <level> may be 0-4; higher levels produce more output.

.p <port> Use <port> as the multicast listening port for communication with ztmd. Default is 2345.

-f Run zqosd in the foreground. Without this option, it is run as a daemon.

-l Log diagnostic output to /var/log/zqosd.log

-i <pid> Set the pid for this process.

-o <pid> Set the pid of the destination process (ztmd)

EXAMPLES

Start the traffic management daemon, ztmd, then start zqosd to monitor tc output. Both daemons are run as background processes and log their messages.

```
ztmd –l

zqosd -l
```

SEE ALSO

ztmd, tc(8), zfilterd

zrc

NAME

zrc - Packet rate control

SYNOPSIS

```
zrc  -b | -m | -d | -t | -a [-p <port>] [-v <vlan>] [-g <group>]
[-M <mac_addr>] [-T <timeout>] [-D <level>] <rate>
```

DESCRIPTION

zrc sets rate control on Broadcast, Multicast and/or Destination Lookup Failure (DLF) packets. The rate is measured in the number of packets per time period. If the number of packets received of the specified type exceeds the specified rate limit, packets are discarded at the ingress port.

OPTIONS

```
-b    Enable rate control for Broadcast packets

-m    Enable rate control for Multicast packets

-d    Enable rate control for DLF packets

-t    Teardown or disable all rate control

-a    Display the current rate control settings

-p <port>  Enable rate control on this <port>

-v <vlan>  Enable rate control for this <vlan_id>

-g <group> Enable rate control for this Multicast <group>

-M <mac_addr>   Enable rate control for this Mac <mac_addr>

-T <timeout>    Set time period to <timeout> milliseconds.
Default is 1000 (one second).

-D <level> Set debugging output to <level> when running the
program.

<rate_limit>    The number of packets per time period above which
Broadcasts, Multicasts and/or DLFs will be discarded. Valid rate
limits are any number between 0 and 262143.
```

SEE ALSO

ztats

zreg

NAME

zreg - Read and write registers and tables on the OpenArchitect switch switching hardware.

SYNOPSIS

```
zreg [-p <ppa>] [-w] [-i <index>] [-t <index>] [-k] [-h
<hostname>] [-d <level>] [-r 10] <reg>
```

DESCRIPTION

zreg allows a user to read and write direct and indirect registers and tables on the resident switch chip. zreg is commonly used for debug, or for prototyping when creating applications that control the OpenArchitect switch. It is also useful when put into shell scripts for displaying hardware status or statistics. Although the -t option allows tables to be displayed, one might find the formatted output of the table functions more useful. See zal.

OPTIONS

-p <ppa> Specify the Physical Point of Attachment (PPA). Each OpenArchitect switch that is controlled by the CPU on which zreg is running is a unique PPA. If there is only one OpenArchitect switch, as would be the case when zreg is running on the embedded processor the PPA would be 0. The default PPA is 0.

-w Causes zreg to write to the register or table. Data to be written is read from standard input.

-i <index> Causes zreg to access at the indexed register specified by <reg>. See OPERANDS for usage of <reg> with indexed registers. The <index> parameter is used to determine which entry i

-t <index> Causes zreg to access the memory specified by <reg>. The <index> parameter is used as the index into the specified table. Only content addressable memories are accessed using the –t option. All other tables and memories are accessed with the –i option.

-k Causes zreg to access the memory specified by <reg>. The entry accessed is determined using the data from standard input as the search key. Enter 0 for fields that are not part of the search key.

-h <hostname> Specify the <hostname> to configure. By default zreg configures the OpenArchitect switch that is locally

connected (i.e., the one that is on the local PCI bus).

-r 10 Sets numeric radix for registers to 10. Default is 16.

-d <level> Set the level of debugging output produced by zreg. The default level is 1. Setting the debug level higher produces more output. The maximum level of output is currently 4.

OPERANDS

<reg> If no –i, -t, or –k option is specified, <reg> is chosen from the en um ix54_reg_e. With the –i option, <reg> is chosen from the enum ix54_xreg_e. With the –t and –k options, <reg> is chosen from ix54_mem_e.

EXAMPLES

There are three types of accesses performed by zreg; scaler register, indexed register, and table. For each of theses access types, values can be read or written. Content addressable memory register access is the default. The following is an example of reading the CONFIG Register:

```
zreg 1
```

When running zreg on the embedded processor of the OpenArchitect switch, the <ppa> is always 0, since the embedded CPU processor only controls the directly attached switch chip. Since the default <ppa> is 0 the -p option is not needed.

To write a value to a register the -w flag is used and the data is read from standard input. The following example writes 0x800000640 to the Aging Time Register:

```
echo 0x80000640 | zreg -w 49
```

If the zreg command is typed at the prompt, it waits for input from the user. You may also use File I/O or shell scripts. The following example reads the MAC Packet Length Register for port 7:

```
zreg -i 7 2
```

SEE ALSO

zal, ztats

zrld

NAME

zrld – ZNYX redirector daemon

SYNOPSIS

```
zrld [-d <level>] [-p <port>] [-f]
```

DESCRIPTION

zrld is used for remote management of OA/HA applications. OA/HA applications capable of remote management include zlc, ztats, zlmd.

zrld only allows requests from hosts listed in /etc/rcZ.d/zrld_trusted_hosts.

OPTIONS

```
-d <level> Set debug level to <level>

-p <port>  Specifies TCP port to listen on. Default port is 7000.

-f         Run the daemon in the foreground
```

EXAMPLES

In the following example, zrld starts a background task that listens on the default port 7000 for incoming TCP requests and passes along the request to the OA/HA application,

```
zrld
```

Once started, you can issue supported commands to the host running zrld from a remote host. For example, if the host running zrld had an IP address of 10.0.0.42, you could use zlc to remotely query the status of ports 1 through 5. Remember, the IP address of the switch you are on must be listed in /etc/rcZ.d/zrld_trusted_hosts on the switch running zrld.

```
zlc –h 10.0.0.42 zre1..5 query
```

SEE ALSO

zlc, zlmd, ztats

zsnoopd

NAME

zsnoopd - IGMP Snooping daemon for the OpenArchitect switch.

SYNOPSIS

```
zsnoopd [-d <level>] [-f] [-h <hostname>] [-p <ppa>]
[-r <sec>] [-t <sec>] [-u <sec>] [-v <vlan_id>]
```

DESCRIPTION

zsnoopd is run after the network interfaces are created and initialized with zconfig, and started with ifconfig(1M). zsnoopd starts a background task that monitors incoming IGMP traffic in order to learn which hosts in a VLAN are listening to which IP multicast addresses. zsnoopd updates the multicast table in silicon with this information, so that IP multicast traffic is forwarded only to the ports in a VLAN to which listening hosts are attached. This optimizes packet flow through the switch. Traffic on all VLANs is monitored by default. IGMP snooping can be restricted to specific VLANs using the -v option. The background task started by zsnoopd continues throughout the life of the Layer 2 network.

zsnoopd manages the switch multicast table. Based on monitored IGMP traffic, zsnoopd creates or updates an entry in the table. The key to each entry is a source Ethernet multicast address combined with a VLAN ID. Two port bitmaps are maintained: one that identifies the untagged members of the VLAN, and one which identifies which ports of the VLAN have listening hosts attached.

When the maximum number of entries in the table is reached, zsnoopd deletes a random entry prior to adding the next entry.

The Ethernet Switch Blade does not perform Multicast routing, but traffic from IP multicast addresses not found in the multicast table is forwarded to all ports within a VLAN. Traffic from reserved IP multicast addresses (224.0.0.X) is forwarded on all ports within a VLAN.

To operate correctly, traffic from unregistered IP multicast addresses should be forwarded on all ports in a VLAN. To do this, the multicast port filtering mode must be set to FORWARD_UNREGISTERED. See zconfig.

Neither zgmrpd nor zgvrpd can run concurrently with zsnoopd.

OPTIONS

-d <level> Sets the level of debugging output required by zsnoopd. The default level is zero (0). Setting the debug level higher produces more output. Four (4) is currently the maximum output level.

-f Run zsnoopd in foreground. Default is to run it in background.

-h <hostname> Connect to remote host <hostname>.

-p <ppa> Start zsnoopd on switch <ppa>. Default is 0.

-r <sec> Time to wait, in seconds, before removing a port with no router multicast traffic. Default is 260 seconds.

-t <sec> Time to wait, in seconds, before removing a port with no host multicast traffic. Default is 260 seconds.

-u <sec> Time to wait, in seconds, before checking port timeouts.

-v <vlan_id> Enable zsnoopd for VLAN <vlan_id>. Default is to enable zsnoopd on all VLANs. This option may be entered more than once.

EXAMPLES

In the following example, `zsnoopd` starts a background task that monitors incoming IGMP packets and updates the Multicast Table (MARL) accordingly. This background task continues throughout the life of the Layer 2 network.

```
zsnoopd
```

Once you run `zsnoopd`, use `zmarl` to display the contents of the MARL. `zsnoopd` deletes all entries in the MARL when starting up, and when shutting down. Manual changes to the MARL are not recommended while `zsnoopd` is running.

SEE ALSO

`zconfig, zgmrpd`

`zpeer peer state query`

The output from the above command during the boot process would be “unhealthy”

The `-a` option can be used to display a complete listing of all state and priority information and internal information that can be used for debugging. Here is example output from the `-a` option.

```
                      Local/Write     Peer/Read
priority                203        231
state                   master           backup

data                     2|cb             2|e7
position byte|bit        2|8              2|0
status                   50(ACK)     0()
```

The priority and state rows are the same values returned by the query command. The information in the data, position and status rows are internal debugging information that is useful to support engineers when diagnosing problems in the field.

The `-r` option should not be used while HA is running. It can cause loss of coordination between the two switch planes. The `-r` option will reset all internal communication values, and possibly require the peer to be reset also.

OPTIONS

`-d` set debug level to <level>

`-a` Display complete status of zpeer

`-r` Reset all values in the zpeer communication. Can cause loss of communication with the peer requiring the peer to be also reset.

SEE ALSO

`zspconfig`

zspconfig

NAME

zspconfig - configure and start surviving partner

SYNOPSIS

```
zspconfig [-d <level>] [-p <directory_path>] [-u
<dhcp_interface>] [-c <dhclient.conf>] [-t <timeout>] [-s]
[-v] -f <file>
```

DESCRIPTION

zspconfig is used to configure and start the Surviving Partner software. With the -f option a configuration file is provided that completely describes the network setup and desired behavior of all of the switches participating in the Surviving Partner. With the -u option the interface on which to run dhclient to retrieve a configuration file must be provided. The configuration file format retrieved by a -u is identical to that supplied with -f. It is envisioned that the -f option is used for initial configuration, and all subordinate and replacement switches run zspconfig with the -u option. The -v option prints the current version of zspconfig and performs no actions.

OPTIONS

-d <level> Set the debug level. The default debug level is 1. The higher the level, the more debugging output is produced. Debugging output is sent to the console.

-p <directory_path>
Set the directory path for where zspconfig places the scripts it generates. The default location is /etc/rcZ.d/surviving_partner.

-u < dhcp_interface>
Come up as an unconfigured slave. Use the specified <dhcp_interface> to retrieve the configuration. User confirmation is not required unless the –s option is also used.

-c <dhclient.conf>
Use file <dhclient.conf> as the configuration file to *dhclient* when retrieving configuration information. If –c is not used, a default configuration file is created and used. Only valid with the –u option.

-t <timeout> Time to wait in seconds before giving up on

```
finding a Surviving Partner to retrieve configuration
information from. Only valid with the –u option.

-s    Do not ask for confirmation. Run from a script.

-v    Prints the current version of zspconfig.

-f <file>  The provided <file> is used as input to configure
the Surviving Partner.  See the next section on CONFIGURATION
FILE for the syntax of the configuration file.
```

CONFIGURATION FILE

The configuration file contains commands for controlling the Surviving Partner setup. Commands are single lines end -delimited with a semicolon. Comments, spaces and new lines are ignored. Comments begin with the # character and include characters through the next new line. Comments may be placed on the same line as a command after the semicolon.

All configurations must include the VLAN configuration first by use of `zconfig` commands. `zconfig` commands can be put in the configuration file and will be passed directly to the `zconfig` application. `zconfig` commands start with the keyword `zconfig` and are of the same format as described in the `zconfig` manual page. Here is an example of `zconfig` commands in a `zspconfig` configuration file.

```
zconfig zhp0: vlan1 = zre1..4;

zconfig zhp1: vlan2 = zre5..8;

zconfig zhp2: vlan100 = zre14;
```

In the above example, three VLANs are created: `zhp0` and `zhp1` will be used as connections to high availability nodes; `zhp2` will be used as the inter-connect between two Surviving Partner switches to run the VRRP heartbeat. All VLANs must be created before other `zspconfig` commands may operate on them.

The next section of a `zspconfig` configuration file sets up the IP addresses of the created VLANs. There are two types of addresses in a Surviving Partner setup: *Physical Addresses*, and *Virtual Addresses*. The Virtual Addresses are those that VRRP manages and moves to the current Master switch. The Physical Addresses are the real addresses of the switch, and are used for management only. Physical Addresses are setup using the `sibling_addresses` command. Virtual addresses are setup using the `virtual_address` command. The sibling addresses name comes from the fact that we are setting up the addresses for all of the siblings in the Surviving Partner group. So if we have two Surviving Partner switches, the `sibling_addresses` statement might look like this:

```
sibling_addresses: zhp0 = 10.0.0.30, 10.0.0.31;
sibling_addresses: zhp1 = 11.0.0.30, 11.0.0.31;
sibling_addresses: zhp100 = 100.0.0.30, 100.0.0.31;
```

A `sibling_addresses` statement is required for each VLAN created with the `zconfig` commands. The two addresses in the list indicate there are two switches in the Surviving Partner group. The first address 10.0.0.30 and 11.0.0.30 are assigned to the switch on which the configuration is being run. The remaining addresses are distributed to the switches that run `zspconfig -u` on a first come, first serve basis.

The `sibling_addresses` command may also take a `netmask` operand similar to that given to `ifconfig`. For example:

```
sibling_addresses: zhp0 = 10.0.0.30, 10.0.0.31 netmask
 255.255.255.0;

sibling_addresses: zhp1 = 11.0.0.30, 11.0.0.31 netmask
 255.255.255.0;
```

```
Virtual addresses should be setup for all VLANs that connect to
High Availability nodes.  Usually this would include all VLANs
except the interconnect VLAN or VLANs connected to upstream
routers.  It is possible that a setup would have VLANs that are
used for management only.  Virtual addresses are setup as
follows:
```

```
virtual_address: zhp0 = 10.0.0.42 netmask 255.255.255.0;
virtual_address: zhp1 = 11.0.0.42 netmask 255.255.255.0;
```

Only a single address per VLAN is provided because this single address will move with the current Master switch, and the *netmask* must be the same as that provided in the sibling_addresses statement.

The last required section for the configuration is description of the ports. Particularly we need to specify one of the following for all of the ports participating in the high availability setup. The possible port types are:

interconnect - Ports connected between groups of Surviving Partner switches. VRRP heartbeat messages are sent on the interconnect ports.

Crossconnect - Crossconnect ports are ports that are connected to other Surviving Partner switches, that are not part of this Surviving Partner group. Crossconnect ports behave differently then bonding ports. The links are not brought down temporarily, and VRRP runs with the native MAC addresses to avoid MAC address duplication with the other VRRP group.

RAINlink - Ports connected to RAINLink or bonding driver nodes. These ports contain virtual addresses managed by VRRP. And during a failover event, the links are toggled down to force failover to the Master switch.

Route - Ports connected to upstream routers. VRRP does not manage virtual IP addresses for these links. Routing protocols must be used to instruct up stream routers of a different path to get to the VRRP managed networks. *These port types are currently not implemented*.

monitor_only - Ports that are monitored but do not have a virtual address managed on them. They will not have their links brought down temporarily during a failover scenario. These ports are only monitored. If a problem occurs on this type of link it will cause a failover scenario.

configure_only - Ports are configured as per the zconfig commands, but do not participate in the high availability network. Problems on these links will not cause a switch failover.

NOTE: The `zhp` specified for interconnect is important, and will be the `zhp` interface/VLAN where `zspconfig`/HA on the the master will start the DHCP daemon. Zre51 on the slave swtiches should be configured up into this same VLAN so that `zspconfig -u` can connect to the master.

Each port that is setup in a VLAN by the `zconfig` commands must have its port type specified. The port type is specified on a physical port bases. That is on a `zre` basis, but `zhp` names can be used as a quick way to setup the port type for all ports that are a member of that VLAN. It is possible to make a port a member of more then one VLAN. That is a `zre` can be a member of more then one `zhp`. In such cases, configuring the `zhps` as different port types would cause a conflict, and will not work. To handle this setup the individual `zre` commands would be used to setup the port types. Here is an example of setting up the port types as a continuation of our current configuration:

```
interconnect:   zhp2; # Could also use zre14

RAINlink:  zhp0, zhp1;     # Could also use zhp0..1,
           # or list the zres
```

The ".." wild card is supported as in `zconfig` to indicate a range of numbers. The comma is used to indicate a list. The `zres` that are part of the `zhp` could also be used. Here is a more complex setup. The `zconfig` commands are also shown to understand the VLAN setup:

```
zconfig zhp0: vlan1 = zre1..4, zre23;
zconfig zhp1: vlan2 = zre5..8, zre23;
zconfig zhp100: vlan100 = zre23;

zconfig zhp0: vlan1 = zre1..4;
zconfig zhp1: vlan2 = zre5..8;
zconfig zhp2: vlan100 = zre23;


#  sibling and virtual address setup omitted

interconnect:   zhp100;
RAINlink:  zre1..8;   # Use zre definition to
                      # exclude zre23
```

If `zhp0` and `zhp100` are setup as different port types, there would be a conflict for port `zre23`. In the particular example above, the `zre23` is shared. It is used to pass VRRP interconnect traffic and as a means to pass VLAN 1 and 2 traffic between switches. Since `zre23` is an

interconnect, it is not a bonding driver enabled port, and therefore should be setup as an interconnect port type. To accomplish this, the zre ports are listed to avoid conflicting port types.

Note that a single line cannot contain both zhp and zre definitions. Therefore

```
RAINlink:  zhp1, zre1..4
```

does not work and the definition zre1..8 is equivalent.

Optional zspconfig commands are listed below.

```
vrrp_msg_rate:  100;  # Time in milliseconds.
                      # Default is 100 milliseconds
```

The message rate is the interval between VRRP messages sent over the interconnect link. The time given is in milliseconds. It takes the lack of 3 VRRP messages for the Backup to assume the role as Master. It is recommended with faster message rates to increase the default priority to 254. The higher priority will decrease the latency of the failover.

```
vrrp_def_priority:    254;  # default is 100.
                            Value from 1 to 254
```

The default virtual MAC address for VRRP is 00:00:5E:00:01:<vid>, where <vid> the virtual router ID. Using this virtual address is problematic in network environments where multiple VRRP instances might be running that are using the same <vid>. To overcome this problem, zspconfig, uses a default MAC address derived from the physical address of the switch on which it is running. For the slave switch, the vrrp_virtual_mac_addr command is used to set the MAC address to the same as the Master. This statement is typically not used within the Master switch's configuration. It is used in the zspconfig generated Slave switch configuration. And is retrieved by the Slave switch with zspconfig using the -u option. If in doubt, don't use this command.

```
vrrp_virtual_mac_addr: 00:01:02:03:04:05
```

There are three failover_modes supported; switch, vlan and port. For switch failover, if any managed link fails, the entire switch is failed over to the backup switch. In vlan failover, if a link fails in a VLAN, only the links associated with that VLAN are failed over. In port failover, only the port that fails is moved to the backup switch. For both vlan and port failover, the interconnect link will need to be used to maintain connectivity between ports that have failed over and those that have not. For vlan and port failover modes, the interconnect link must be an in-band port, and must be included in the managed VLANs running with VLAN tagging on.

```
failover_mode:  switch;
failover_mode:  vlan;
failover_mode:  port;
```

Coordination between the data and fabric switches can be enabled by setting the board_synchronization_mode. Possible modes are "off" and "basic". Board synchronization is off by default. When board synchronization is put into basic mode, HA events on the base switch are coordinated with the HA events on the fabric switch. The behavior of board synchronization is dependent on the failover_mode. In switch failover_mode all VLANs are moved to the HA partner with the most up links in unison. With board synchronization the concept is extended so that all VLANs in both switching planes are moved to the HA partner with the most up links in both switch planes. So, both switches failover together. In vlan and port failover modes the number of up links is not considered in the board synchronization. Each vlan or port can move independently across the data or fabric planes between HA partners according to the failover_mode rules. In all failover_modes, if the data plane or fabric switch reboots or power cycles, the HA partner will take mastership for all VLANs in both planes. The syntax for setting the board_synchronization_mode is:

```
board_synchronization_mode:     basic;
```

Additional startup scripts may be included in the configuration using the start_script command. The files in the start_script command will be placed in a location for tftp transfer to sibling switches that initialize using the -u option. A common use of the start_script command might be to propagate *gated* configurations to all members of the Surviving Partner group. Absolute path names must be used. Using multiple commands allows inclusion of multiple scripts. For example:

```
start_script: /etc/rcZ.d/S75gated;
start_script: /etc/rcZ.d/S80static_routes;
```

The vrrpd_script command allows a user defined script to be run when vrrpd changes state. This script is called at the end of the zspconfig created vrrpd.script. See vrrpd -s for a description of when the scripts are called. zspconfig sets up vrrpd to call vrrpd.script. The vrrpd_script command in zspconfig places a call to the user-defined script at the end of vrrpd.script file. The following example would call the my_vrrpd_script each time vrrpd calls its -s provided script:

```
vrrpd_script:  /etc/rcZ.d/surviving_partner/my_vrrpd_script;
```

CAUTION: The my_vrrpd_script is not called from a different process thread. Therefore if my_vrrpd_script crashes or has long delays, it will crash the vrrpd, or cause delays in the Surviving Partner failover. To protect against this, write the script to launch a second script in a background shell. The advantage to calling the user provided script in the same process thread is that it gives synchronized control over the failover process for those who want it.

OUTPUT FILES

The output of zspconfig is a set of configuration and script files. The configuration files configure vrrpd and zlmd daemons. The vrrpd and zlmd daemons combined with the script

files run the Surviving Partner. This is a list of all configuration and script files:

```
/etc/rcZ.d/S70Surviving_partner
The main startup script that starts the Surviving Partner by
running  zconfig, ifconfig, zlmd and vrrpd.  zspconfig prompts
the user to run this script.  This file can be saved with
zsync to automatically start the Surviving Partner at switch
boot.

/etc/rcZ.d/surviving_partner/vrrpd.conf
Configuration script for the VRRP daemon.  This configuration
is used when the S70Surviving_partner script launches vrrpd.
There is a line in this file for each router address vrrpd
will manage.  Or stated another way, each virtual_address
command in the zspconfig configuration file results in a line
in vrrpd.conf.

/tftpboot/zsp.conf<n>
zspconfig configuration file that contains the configuration
of the sibling backup switches.  The <n> is used to
distinguish potentially more than one backup switch.  This
configuration file is placed in /tftpboot, and is retrieved
via DHCP by a replacement switch on boot up.

/etc/rcZ.d/surviving_partner/dhcpd.conf
Configuration script used by dhcpd when the switch becomes
master.  dhcpd is used to serve replacement switches their
configuration scripts.  Namely a zsp_DC.conf file that can be
input to the zspconfig with the -u flag.

/etc/rcZ.d/surviving_partner/dhclient.conf
If zspconfig is executed with the -u flag, a dhclient.conf
file is created, and then dhclient is used to retrieve a
zspconfig configuration file from the /tftpboot area of the
Master switch.

/etc/rcZ.d/surviving_partner/vrrpd.script
Runtime script that executes each time the vrrpd changes
state.  This script starts and stops dhcpd, and toggles down
bonding driver/RAINlink ports to force the  nodes to a new
Master switch.

/etc/rcZ.d/surviving_partner/zlmd.script
Runtime script executed by zlmd when a link goes up or down.
This script modifies the priority of vrrpd, which in turn may
cause the VRRP Master to move from one sibling switch to
another.
```

SEE ALSO

zconfig, ifconfig, vrrpd, dhclient, dhcpd, zpeer

zstack

NAME

zstack - Configures the OpenArchitect switch stacking.

SYNOPSIS

```
zstack [-h <host_name>] [-d <level>] [-a] [-t] [{-f <file>} |
<configuration>]
```

DESCRIPTION

zstack combines multiple switch fabric chips into a single virtual switch. zstack must be run before any other switch configuration. Specifically it must be run before zconfig. zstack is typically run from an S20stack script prior to the S50xxx scripts. zstack currently only supports directly connected switch chips as are present on the base switch. Directly connected means that the local CPU can directly access and control the switch fabric chips being stacked. zstack does not yet support network based stacking where there are separate boards with separate CPUs controlling the switch fabric chips.

OPTIONS

-h <hostname> Specifies the remote hostname to configure. By default, zstack configures stacking on the local OpenArchitect switch. This option should only be used for displaying the configuration, if at all.

-d <level> Sets the level of debugging output produced by zstack. The default level is 1. Setting the debug level higher produces more output. The maximum output level is currently four (4).

-a Displays the current stacking configuration of the switch.

-t Tears down the entire switch stacking configuration.

{-f <file>} | <configuration>
Gets configuration information from the specified file. A <file> name of '+' reads configuration data from standard input. If the -f flag is not used, a single line of configuration data can be entered as parameters to zstack.

CONFIGURATION SYNTAX

zstack takes configuration data from standard input or from a file with the -f option. In either case, the configuration syntax is the same. The zstack configuration data consists of a list of

semicolon-delimited statements. Each statement specifies an action to take on a stack. A stack is a group of ports on a single switch fabric chip. Actions include `stack creation`, `stack port association`, `stack configuration` and `stack control`.

Comments, spaces and new lines are ignored. Comments begin with the # character and include characters through the next new line.

Stack Creation

The first step in creating a stack is to define its location. Each stack is assigned a unique small integer by the user. On the base switch this integer must be a value from 0 to 31. The location is defined with two values; a Physical Point of Attachment (ppa) and a network location. The ppa is defined by the keyword "ppa" followed by an integer value. The integer value is a 0 based contiguous value representing the physical switch fabric chip as it was discovered by the Linux operating system. In the case of the base switch there are two chips directly controlled. The network location specifies an IP address of the CPU that controls the physical switch fabric chips. If the CPU that is running `zstack` controls the physical switch fabric chip, the key word "local" is used in place of the IP address. Currently only "local" CPU control is supported.

Stack creation example for a base switch:

```
stack0: ppa0 local;

stack1: ppa1 local;
```

The above statements indicate that there are two switch fabric chips that are controlled by the local CPU.

Stack Port Association:

After stack creation, the physical ports must be associated with a virtual port name. One might think of this as mapping the ports from their physical association to a virtual name. The physical port numbers are usually 0 based, but are dependent on how the ports are physically configured in the switch fabric silicon and how those ports are labeled at the physical connector. At a minimum the port association is used to move the ports of a second, third, or more switch silicon chip to a different virtual port name then the others. In this way, the ports can be built into a unique linear port list.

Stack port association syntax:

```
stack<N>: <zre_list> = <zre_list>;
```

The port association statement begins with the stack and number representing the group of ports being mapped. The stack must be previously created with a stack creation command. After the

semicolon are two `zre_lists` separated by an equal sign. The first is the list of virtual port names, the second is the physical port names. The assignment is done in order, and there must be an equal number of ports in each list. Wild cards may be used in the `zre_lists`. See below.

Stack port association syntax for a base switch:

```
stack0: zre0..11 = zre0..11;

stack1: zre12..23 = zre0..11;
```

The first statement above configures the first switch silicon chip, represented by stack0, to have no translation between its physical port numbering and its virtual port numbering.

NOTE: The statement must be made even if the mapping is one to one.

The second statement above configures the second switch silicon chip to have its physical ports 0 through 11 map to virtual ports 12 through 23. The mapping is done in a linear fashion. `zre0` maps to `zre12`. zre1 maps to `zre1` and so on.

Stack Configuration Statements

After stack creation and port association, the configuration of the stack must be defined. The stack configuration provides the network map of how inter-switch fabric communication is performed. It specifies which physical port or should be used to communicate with a different group of stacked ports. The syntax is as follows:

```
stack<N>: stack<M> = zre<n>;
```

The above syntax indicates that stack N should use `zre` n to access stack M. The `zre` value n is a physical port number as seen by Stack N. It is not a virtual port number as mapped by a port association command. Multiple configuration statements for Stack N can be used to indicate how to get to other stacks.

NOTE: `stack<M>` can be a list of comma delimited or range of stacks as described below in the section on wild cards.

Stack port association example for a base switch:

```
stack0: stack1 = zre12;

stack1: stack0 = zre12;
```

The above example indicates that stack0 is connected to stack1 through the port 12 and stack1 is connected to stack0 through port 12. `Zre12` on the base switch switch fabric chips is the HIGIG port and are directly connected between the two devices.

Stack Control Statements

Finally after creating the stack, associating the ports, and setting the stack configuration, the stack can be enabled using one of the Stack Control statements. The following stack control statements are supported.

```
enable;
```

The enable statement turns on stacking that has been previously configured. This statement cannot be made until configuration is complete.

```
disable;
```

The disable statement turns off stacking. Before disabling stacking, all ZNYX daemons must be stopped, and the VLAN configurations must be torn down using `zconfig`.

WILDCARDS

Wild card characters can be included to simplify the process of creating larger, more complex configurations. Wild card characters for `zconfig` include:

```
,    (comma)      Use for creating lists
..   (dot-dot)    Specifies an inclusive range
```

Below are some examples for the correct usage of the comma (,) and dot-dot (..). Each line below produces the same results:

```
stack0: zre4..7 = zre0, zre1, zre2, zre3;

stack0: zre4, zre5..7 = zre0..3;

stack0: zre4..7 = zre0, zre1..3;

stack0: zre4, zre5..7 = zre0..1, zre2..3;
```

The stack may also be in list form in the Stack Configuration command in similar fashion to the `zre` lists. Example of stack0..3 representing stacks 0, 1, 2 and 3.

SEE ALSO

`zconfig`

ztats

NAME

ztats – Display statistics and information about switch

SYNOPSIS

```
ztats  [-d <level>] [-i <unit>] | [-m <port>] |
[-v <vlan id>] | [-t <tgid>] | [-v]
```

DESCRIPTION

ztats displays MIB counters for a selected physical port, trunk group or VLAN. It can also display information about the configuration of the switch and bridge to the PCI bus or the Vital Product Data memory. All output is formatted.

OPTIONS

-m <port> MIB statistics for specified <port>

-v <vlan id> MIB statistics for specified <vlan id>

-i <unit> Information for specified <unit>:

0 is BCM5695 ports 0-11,

1 is BCM5695 ports 12-23.

-d <level> Set debug level to <level>

-t <tgid> MAC layer statistics for all ports in trunk <tgid>.

-v Vital Product Data (not currently supported in base switch)

EXAMPLES

To display statistics for a particular port on the switch, such as port 0.

```
ztats –m 0
```

SEE ALSO

zreg, zal

zsync

NAME

zsync – Saves changes to the flash.

SYNOPSIS

```
zsync [-c][-f][<dir_or_file>]

zsync [-c][-f][-t <file>]

zsync [-c][-f][-z]

zsync [-c][-l]
```

DESCRIPTION

zsync is used to save a snapshot of the current file system to flash ROM. By default, zsync creates a compressed tar image of the files that have changed and saves the image in the flash ROM. The saved image is expanded on reboot. The saved compressed tar image is called an "overlay".

If a directory parameter is given to zsync, the contents of the directory are saved instead of searching for updated files. The specific purpose of the <directory> parameter is for saving files that have been mounted with zmnt. Using the -t option allows a tar image created by zmnt -t to be saved.

To correct a corrupted file that is saved to flash ROM with zsync, first reboot with the -i option (*see Switch Maintenance*). Use zmnt to put the corrupted file in the /mnt directory, open and correct the file, then zsync to the /mnt directory to save your changes and reboot.

There are two overlay areas: *dynamic* and *custom*. The dynamic overlay is the default. The custom overlay is used to create base configurations that are different then the base configuration. The custom overlay is written by using the -c option.

The -z option zeros the overlay area, returning the switch to the factor configuration.

Specific files or directories can be excluded from saving to flash by zsync by including an entry in /etc/exclude. Likewise, existing entries in /etc/exclude such as /tmp can be removed in order to save those files to flash with zsync.

OPTIONS

-c Save files to the custom overlay

-t <file> Read files to be saved from a tar file.

-z Zero the overlay area.

-f Do not confirm with user and do not warn if saving failed. Exit code can be examined to determine success or failure.

<dir_or_file> Save only the named file, or save the named directory to the overlay. Contents of directories must be created with zmnt.

-l List files that would be written. Do not flash.

EXAMPLES

To zsync only the hosts file:

```
cd /etc

zsync hosts
```

If you previously created a snapshot of an overlay to a tar file using zmnt,

```
zmnt –t overlay.tar
```

You can use zsync to restore the overlay on the switch directly from the tar file,

```
zsync –t overlay.tar
```

The restored overlay will be loaded upon the next reboot.

FILES

/etc/exclude, /.zsync

SEE ALSO

zmnt

ztmd

NAME

ztmd – traffic management daemon which accepts messages from traffic filtering and quality of service applications and sets up hardware.

SYNOPSIS

```
ztmd [-d <level>] [-p <port>] [-f] [-i <pid>]
[-o <pid>] [-a <addr>] [-l]
```

DESCRIPTION

ztmd listens for messages on a multicast port. These messages describe packet filters and queuing disciplines that are to be installed in the switch hardware. ztmd interprets these messages to set up the switch hardware.

OPTIONS

-d <level> Set the level of diagnostic information logged. <level> may be 0-4; higher levels produce more output.

.p <port> Use <port> as the multicast listening port for communication with ztmd. Default is 2345.

-f Run ztmd in the foreground. Without this option, it is run as a daemon.

-i <pid> Set the PID for this process (default is 1)

-o <pid> Set expected client PID.

-a <addr> Bind multicast socket to <addr>

-l Log diagnostic output to /var/log/ztmd.log

EXAMPLES

Start the traffic management daemon, ztmd, then start zqosd to monitor zstats output and zfilterd to monitor iptables(8) output. All daemons are run as background processes and log their messages to files in /var/log.

```
ztmd –l

zqosd –l

zfilterd -l
```

SEE ALSO

zqosd, iptables(8), tc(8), zfilterd

brctl(8)

NAME

brctl - Bridge and Spanning Tree Protocol administration.

SYNOPSIS

```
brctl [options]
```

DESCRIPTION

brctl is used to set up, maintain, and display the bridge configuration in the Linux kernel. brctl is a standard command included with Linux bridge support including Rapid Spanning Tree Protocol (RSTP).

A bridge is a device commonly used to connect different networks together, so that these networks will appear as one network to the participants.

Each of the networks being connected corresponds to one physical interface, or port in the bridge. These individual networks are bundled into one bigger logical network. This bigger network corresponds to the bridge network interface.

Multiple bridges can work together to create even larger networks using the IEEE 802.1d Spanning Tree Protocol. This protocol is used for finding the shortest path between two networks as well as eliminating loops from the topology. Bridges communicate with each other by sending and receiving Bridge Protocol Data Units (BPDUs).

brctl(8) can be used for configuring certain spanning tree protocol parameters. For an explanation of these parameters, see the IEEE 802.1d specification for detailed information.

OPTIONS

```
addbr  <bridge>
creates a new instance of a bridge. The network interface
corresponding to the bridge will be called <bridge>. For the
OpenArchitect switch, bridges are named bzhp0, bzhp1, etc.
```

IMPORTANT: This option must only be executed by zl2d.

```
delbr  <bridge>
deletes the instance <bridge> of an Ethernet bridge. The network
interface corresponding to the bridge must be down before it can
be deleted.
```

IMPORTANT: This option must only be executed by zl2d.

```
show  shows all current bridges.

addif  <bridge>  <interface>
```

makes the interface a port of the bridge. This means that all frames received on the interface will be processed as if destined for the bridge. Also, when sending frames on the bridge, the interface will be considered as a potential output interface. For the OpenArchitect switch, <interface> is zhp0, zhp1, …

IMPORTANT: This option must only be executed by zl2d.

delif <bridge> <interface>
detaches the interface from the bridge.

IMPORTANT: This option must only be executed by zl2d.

showbr <bridge>
shows information for the bridge and its attached ports. Check the priority using this command.

showmacs <bridge>
shows a list of learned MAC addresses for the bridge.

setageingtime <bridge> <time>
sets the Ethernet (MAC) address aging time, in seconds. After <time> seconds of not having seen a frame coming from a certain address, the bridge will time out (delete) that address from the Forwarding DataBase (fdb).

setgcint <bridge> <time>
sets the garbage collection interval for the bridge to <time> seconds. This means that the bridge will check the forwarding database for timed out entries every <time> seconds.

stp <bridge> <state>
controls this bridge's participation in the Spanning Tree Protocol. <state> can be "off" or "on". When turned off, the bridge will not send or receive BPDUs, and will thus not participate in the Spanning Tree Protocol.

CAUTION: If your bridge isn't the only bridge on the LAN, or if there are loops in the LAN's topology, DO NOT turn this option off. If you turn this option off, please know what you are doing.

setbridgeprio <bridge> <priority>
sets the bridge's priority to <priority>. The priority value is an unsigned 16-bit quantity (a number between 0 and 65535), and has no dimension. Lower priority values are better. The bridge with the lowest priority will be elected Root Bridge.

setfd <bridge> <time>
sets the bridge's bridge forward delay to <time> seconds.

sethello <bridge> <time>
sets the bridge's *bridge hello time* to <time> seconds.

`setmaxage <bridge> <time>`
`sets the bridge's maximum message age to <time> seconds.`

`setpathcost <bridge> <port> <cost>`
`sets the port cost of the port to <cost>. This is a dimensionless metric. The path cost is set to 100 for all OpenArchitect switch ports by default. IEEE 802.d recommends the following:`

Link Speed	Recommended Value	Recommended Range
10 Mb/s	100	50-600
100 Mb/s	19	10-60
1 Gb/s	4	3-10

`setportprio <bridge> <port> <priority>`
`sets the port's priority to <priority>. The priority value is an unsigned 8-bit quantity (a number between 0 and 255), and has no dimension. This metric is used in the designated port and root port selection algorithms. For the OpenArchitect switch a port is zre1, zre2, …`

NOTES

`brctl(8)` replaces the older `brcfg` tool.

SEE ALSO

`zconfig, zl2d`

Appendix C Intelligent Platform Management Interface

The Ethernet Switch Blade provides Intelligent Platform Management Interface (IPMI) support. IPMI circuitry provides:

- The communication channel between the Baseboard Management Controller (BMC) and the CPU for management.
- Data storage, SDRR, FRU, access.
- Sensor readings.

IPMI circuitry on the Ethernet Switch Blade peripheral management controller (PMC) provides three I^2C compatible serial interfaces:

I^2C Port 0	Connects to the BMC on an Alarm or System card. The bus is called IPMB. Via this connection the PMC can send status events, SDR 's and FRU information to the BMC. It can also receive commands and control information from the BMC.
I^2C Port 1	Connects to the Ethernet Switch Blade CPU and the "spare" SEEPROM.
I^2C Port 2	Connects to the boot and run time SEEPROMs as well as the switch silicon.

ISwitch-ShMC Interaction

- Switch reports state changes to ShMC.
- If event reporting is enabled, an event will be generated by the switch whenever a sensor threshold is crossed.
- Policy is enforced by the ShMC.
- Typical ShMC policy is to remove back-end power from a FRU that has crossed a threshold.

M States	
M0	No power and hot swap handle open
M1	No communications. (Wait in M1 until hot swap ejector is closed)
M2	FRU announces its presence to the ShMC and awaits activation permission
M3	Activation
M4	Operational state (command issued to enable back-end power)

M States	
M5	Deactivation request (e.g. hot swap ejector opened)
M6	Deactivation granted by ShMC
M7	Unexpected loss of communication between FRU and ShMC

Table C.1.: IPMI M States

Peripheral Management Controller Functional Support

The following IPMI commands are implemented in version 1.00:

PMC Controller Support				
Command	**Code**	**Sensor #**	**Status**	**Notes**
GetDevID	0x01		Mandatory	
BroadcastGetDeviceID	0x01		Mandatory	
ColdReset	0x02		Optional	
GetSelfTestResult	0x04		Mandatory	
GetSensorReading	0x2D		Mandatory	
TempSensor		60		Returned in Celsius
A2D_0		41		Full 8-bit value (255) represents 3.3 Volts; scale returned value accordingly
A2D_1		42		
A2D_2		43		
A2D_3			Not used	
A2D_4		45		
A2D_5			Not used	
SetSlotPower	0x12		Vendor specific	
SetSlotBlueLed	0x13		Vendor specific	
SetSlotReset	0x15		Vendor specific	

Table C.2: PMC Controller Support

Sensor Reading Example

This is an example of how to structure a command and response to determine a sensor value. In this example, a GetSensorReading command is sent from BMC (address 20h in this example), to the switch in slot 2 (geographical address is B2h) to read the temperature sensor, which is assigned to sensor number 60h.

Standard IPMI Command: GetSensorReading		
Byte	**Data Field**	**Description**
1	rsAddr	B2h
2	netFn/Lun	10h
3	check1	3Eh
4	rqAddr	20h
5	seq no	06 (random pick)
6	command	2Dh
7	sensor number	60h
8	checksum2	4Dh

Table C.3: GetSensorReading

Standard IPMI Response: GetSensorReading		
Byte	**Data Field**	**Description**
1	rqAddr	20h
2	netFn/Lun	16h
3	check1	CAh
4	rsAddr	B2h
5	seq no	06
6	command	2Dh
7	completion code	00h
8	sensor reading	1Bh -> 27 Celsius degree
9	optional data byte	C0h scanning is enabled
10	optional data byte	C0h
11	optional data byte	00
12	checksum2	80h

Table C.4: GetSensorResonse

Only scanning is supported and enabled for the optional bytes.

Structure of Standard IPMI Commands: From BMC to PMC

Structure of Standard IPMI Commands BMC - PMC		
Byte	**Data Field**	**Description**
1	rsAddr	<slot's IPMB addr>
2	netFn/Lun	<netFn>
3	check1	<chksm1>
4	rqAddr	<sw_id>
5	seq no	<seq>
6	command	<cmd>
7	optional data byte	<arg1>
7+x	optional data bytes	<argN>
7+x+1	check2	<chksm2>

Table C.5: Standard IPMI Commands

Structure of Standard IPMI Responses: From PMC to BMC

Structure of Standard IPMI Responses PMC - BMC		
Byte	**Data Field**	**Description**
1	rqAddr	<sw_id>
2	netFn/Lun	<netFn>
3	check1	<chksm1>
4	rsAddr	<slot's IPMB addr>
5	seq no	<seq>
6	command	<cmd>
7	completion code	<ccode>
8	optional data byte	<arg1>
8+x	optional data bytes	<argN>
8+x+1	check2	<chksm2>

Table C.6: Standard IPMI Responses

Event Generator

The PMC's event generator is disabled until it receives a `SetEventReceiver` command from BMC for Event Receiver's slave address and LUN. If the event generator is enabled, PMC reports significant events to the BMC asynchronously.

The standard IPMI platform event message format is used.

IPMB Event message format

Structure of event messages sent to the BMC by PM device (PMC) is shown below.

IPMB Event Message Format		
Byte	**Data Field**	**Byte Description**
1	EvMRev	<event_msg_rev>
2	Sensor Type	<sensor_type>
3	Sensor #	<sensor_number>
4	Event Dir | Type	<direction, type> bit: 7
4	Event Type	<type> bits: 0-6
5	Event Data 1	<arg1>
6	Event Data 2	<arg2>
7	Event Data 3	<arg3>

Table C.7: Event Message Format

IPMI Event Message Definitions

The following tables describe the IPMI event messages to be generated by the PMC. The basic requirement is that when a monitored sensor changes state, an event must be generated and sent to BMC.

Field Replaceable Unit Inventory Device

A Field Replaceable Unit Inventory Device (FRU ID) file is generated for the Ethernet Switch Blade in binary format. At manufacturing, the file is loaded at the same time as the boot and runtime files to a specified space, which is reserved in the spare SEEPROM on I^2C bus number 1 at device address 0xA2. The FRU information is product specific and, in addition, may be customer specific. At boot time, the IPMI firmware will read the product serial number from the board's VPD file to FRU's product Information Area.

Version 2.x supports three FRU Inventory Device Commands:

```
Get FRU Inventory Area Info

Read FRU Data

Write FRU Data
```

The spare SEEPROM space is allocated as follows:

Spare SEEPROM Space Allocation				
Space for	**Start address**	**End address**	**Size**	**Notes**
VPD	0	0x3FF	0x400 (1Kbytes)	
FRU	0x400	0x13FF	0x1000 (4kbytes)	
Parameters	0x1400	0x17FF	0x400 (1 Kbytes)	
Attribute	0x1800	0x37FF	0x2000 (8 Kbytes)	

Table C.8: SEEPROM Space

IPMB Override/Local Status - Event Data 3 for the IPMB link

IPMB Override Status Data		
Bit(s)	**Type**	**Notes**
7	IPMB B Override State	0=Override state, bus isolated; 1= Local Control state - IPM Controller determines state of bus
6:4	IPMB B Local Status	0=No Failure. Bus enabled if no override in effect; 1=Unable to drive clock HI; 2=Unable to drive data HI; 3=Unable to drive clock LO; 4= Unable to drive data LO; 5= Clock low time out; 6=under test; 7=Undiagnosed communications failure
3	IPMB A Override State	0=Override state, bus isolated; 1= Local Control state - IPM Controller determines state of bus
2:0	IPMB A Local Status	0=No Failure. Bus enabled if no override in effect; 1=Unable to drive clock HI; 2=Unable to drive data HI; 3=Unable to drive clock LO; 4= Unable to drive data LO;

IPMB Override Status Data		
		5= Clock low time out; 6=under test; 7=Undiagnosed communications failure

Table C.9.: IPMB Override Status Data

Index